PROCESS SPECIFICATIONS AND TECHNICAL MANUAL FOR THIN METAL FILM CORROSION INDICATORS

MAGNA CORPORATION
Research and Development Laboratories
Anaheim, California
Contract AF 33(600)-42151
31 January 1962

FABRICATION BRANCH
MANUFACTURING TECHNOLOGY LABORATORY
DIRECTORATE OF MATERIALS & PROCESSES
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FOREWORD

This document represents the final process specifications and technical manual for Magna Corporation's development work on thin metal film corrosion indicators. Work was done under U. S. Air Force Contract Number AF 33(600)-42151.

This document was coordinated and written by Lloyd Polentz based on technical information provided by Jack D. Guttenplan (project leader), Ted. M. Doniguian, David Roller and Dr. Willard R. Scott, Jr.

MILITARY SPECIFICATIONS

INDICATOR, CORROSION, "MATCHBOOK," THIN-METAL-FILM, VISUAL

1. SCOPE

1.1 Scope. This specification covers one type of visual corrosion indicator. This indicator is intended principally for use in detecting the presence of a corrosive atmosphere inside a container within which an article is packaged. It will serve to indicate whether or not the article has been exposed to a corrosive environment.

1.2 Classification

1.2.1 Type and classes. Matchbook visual corrosion indicators covered by this specification shall be of one general-purpose type and of the following classes, as specified in the contract or purchase order.

Class 1. Standard sensitivity

Class 2. Special, accelerated sensitivity

2. APPLICABLE DOCUMENTS

2.1 The following specifications and standards, of the issue in effect on date of invitations for bids, form a part of this specification:

SPECIFICATIONS

Federal

L-V-351 - Vinyl Chloride Polymer and Copolymer Rigid Sheets

TT-P-141 - Paint, Varnish, Lacquer, and Related Materials, Methods of Inspection, Sampling, and Testing

PPP-C-96 - Cans, Metal, 28 Gage and Lighter

Military

JAN-P-103 - Packaging and Packing for Overseas Shipment - Boxes, Wood-cleated, Solid-Fiberboard

JAN-P-106 - Packaging and Packing for Overseas Shipment - Boxes, Wood, Nailed

JAN-P-108 - Packaging and Packing for Overseas Shipment - Boxes, Fiberboard (V-Board and W-Board), Exterior and Interior

MIL-B-107 - Boxes, Wood, Wirebound (Overseas Type)

MIL-L-10547 - Liners, Case, Waterproof

MIL-P-116 - Preservation, Methods of

MIL-D-3464 - Desiccants, Activated, Bagged, for Packaging Use and Static Dehumidifications

STANDARDS

Military

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-129 - Marking of Shipments

2.2 Other Publications. - The following document forms a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

American Society for Testing Materials

ASTM Standard E 104-51 - Maintaining Constant Relative Humidity by Means of Aqueous Solutions

3. REQUIREMENTS

3.1 Acceptability. - The corrosion indicators furnished under this specification shall be products which have been tested and have passed the acceptance tests specified herein. The corrosion indicators are particularly sensitive to any exposure to air with a relative humidity greater than 40%, or air containing acid vapors. Particular care should be exercised that any atmosphere to which the indicators are subjected after metal film coating, and before they are placed in use, has a relative humidity of less than 40%, and that they are not exposed to corrosive vapors of any kind. Care should also be exercised in handling the indicators to prevent any contamination of the metal film surfaces. These surfaces should be kept free from all foreign material and scratches and should never be touched or marked with fingerprints. These handling precautions are necessary to ensure that the indicators will perform as specified. The function of the

matchbook corrosion indicator is to indicate the fact that the atmosphere to which it has been exposed has been or is corrosive, and it must do this irreversibly. Furthermore, to provide adequate forewarning of potentially corrosive conditions, it must be very sensitive. The indicator senses all corrosive conditions to which it is subjected. It cannot discriminate between a corrosive condition before it is placed in use and such a condition after it has been placed in use. In addition, there must be a certain built-in delay period to protect the indicator during the package-pull-down period, during which period the relative humidity may be such that conditions are definitely corrosive. If too much of the delay period is used up through exposure of the indicator to corrosive conditions before it is placed in a package, then there will not be enough left to protect it during the package-pull-down period, and the indicator will erroneously indicate a potentially corrosive condition.

3.2 Description, general. - This specification covers a device for visually indicating the presence of a corrosive atmosphere in a sealed unit (chest, package, container, cabinet, housing, etc.) or in a relatively closed environment such as a warehouse, storeroom, etc. The indicator shall consist of a piece of transparent plastic, the approximate shape and size of a paper matchbook cover, see Fig. 1. One side of the inner face of the plastic shall be coated with a thin film of ferrous metal. On the back side of the metallized area a label on which the instructions for use have been printed shall be permanently attached.

3.3 Performance. - The visual corrosion indicator shall be so designed and constructed that it will perform as described in the following sub-paragraphs.

3.3.1 Response Characteristics - General. In order that the indicator performs its function, it shall show two distinct phases of response when contacted by a corrosive atmosphere. The first phase shall be an inhibited period, wherein no visible change occurs, and shall be known as the "delay period." The second phase shall consist of a change of color and shall immediately follow the delay period. The delay period is described further in para. 3.3.2. The color change is described further in para. 3.3.3.

3.3.2 Delay period

3.3.2.1 Class I Indicator. - The sensitive film surface of the indicator will be treated so as to delay its corrosion or color change for a period of 60 $\pm$ 24 hours when in an atmosphere of 60% R.H. at 25°C. This built-in delay is necessary to ensure an accurate reading since the atmosphere packaged with the equipment may initially be corrosive. The minimum delay period of 36 hours should be adequate to allow for a reasonable amount of handling time plus the time which will elapse before the desiccant placed in the container will have absorbed the moisture in the packaged air (packaging pull-down period) and the environment will become non-corrosive.

3.3.2.2 Class 2 Indicators. - The Class 2 indicators are designed to be used to indicate the condition of packaged Class 1 indicators. Since Class 1 indicators will be packaged in an atmosphere of 40% R.H. or less, the Class 2 indicators would be subjected to relative humidities greater than 40% only during the periods of time when the container was opened for removal of Class 1 indicators. For this reason, the delay period of Class 2 indicators is much less critical than the delay period of Class 1 indicators. There should be a small delay period to enable the Class 2 indicators to withstand the short periods when the container is opened for removal of Class 1 indicators, and the delay period should not be excessive. Thus the delay period of the Class 2 indicators should not be less than 2 hours, nor more than 12 hours.

3.3.3 Color Change. - Exposure of the indicator to a corrosive atmosphere shall result in a change in the color of the film-coated area from silver-gray to orange-brown. This change will take place progressively over a period of time, starting with small, randomly distributed spots, and spreading to cover the greater portion of the area.

3.4 Protective Treatment. - When materials are used in the construction of the matchbook visual corrosion indicator that are subject to deterioration when exposed to climatic and environmental conditions likely to occur during service usage, they shall be protected against such deterioration in a manner that will in no way prevent compliance with the performance requirements of this specification. The use of any protective coating that will crack, chip, or scale with age or extremes of climatic and environmental conditions will be avoided.

3.5 Dimensions. - The over-all dimensions of the matchbook visual corrosion indicator will be as shown in Fig. 1.

3.6 Weight. - The weight of one complete matchbook visual corrosion indicator will be less than one ounce.

3.7 Material. - Each matchbook visual corrosion indicator shall consist of a formed, metal-film-coated piece of clear, transparent plastic with an identification and instruction label permanently glued to the back.

3.7.1 Component material.

3.7.1.1 Clear plastic. - The plastic shall conform to Spec. No. L-V-35, Class 1. It shall be an optically clear material which should show no discoloration, cracking, delamination, or checking during use.

3.7.1.2 Metal film. - The corrosion sensitive ferrous metal film shall be vacuum plated on the plastic to an acceptable thickness as determined by the test described in paragraph 4.4.3. The plating shall be done in accordance with the best industrial vacuum plating standards and the resulting film shall be of the highest quality. The film shall be uniform and homogeneous over its total area and shall be free from pits, blank spots, or any localized points of metal build-up in accordance with the best industrial standards.

3.7.1.3 Label. - The label will be of the pressure-sensitive type. It shall be imprinted clearly with a good grade of ink with a high degree of permanency. The adhesive used to attach the label to the indicator shall be of a high quality and shall not become brittle with age nor lose its adhesive strength. The adhesive shall be of such a color that it will not interfere with the reading of the indicator. Furthermore, it shall be of such a composition that the color will not change with age to the point where it might interfere with any future reading. The details of the label are as shown in Fig. 2.

3.8 Workmanship. - All details of manufacture shall be in accordance with good commercial practice. The finished product should be free of any and all imperfections which would impair its usefulness.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of Tests. - The inspection and testing of the matchbook visual corrosion indicators shall be classified as acceptance tests.

4.2 Acceptance Tests. - Acceptance tests shall consist of:

a. Individual tests

b. Batch tests

c. Sampling plans and tests

4.2.1 Individual Tests. - Each matchbook visual corrosion indicator shall be subjected to visual examination as described under 4.4, Test Methods, of this specification.

4.2.2 Batch Tests. - The film thickness of the indicators shall be measured by including three test samples, each one inch square or larger in size, with each batch of indicators which is vacuum plated. These three samples shall be placed in the vacuum plating chamber with the indicators being vacuum coated. They shall be located so that one shall be placed at each end of the vacuum chamber and the third shall be located midway between the two ends of the chamber. All of the test samples shall be the same distance from the axis of the chamber as the indicators being coated and all shall be held in the same fashion. In short, they shall be subjected to exactly the same conditions as the indicators which are being coated. Upon the conclusion of the vacuum coating process, the three samples shall be checked for the thickness of the metal film by the method described in paragraph 4.4.3, and if the thicknesses of the three samples are within the acceptable limits the batch shall be considered acceptable.

4.2.3 Sampling plan and tests

4.2.3.1 Sampling. - The acceptance sampling will be in accordance with the provisions of Standard MIL-STD-105. Samples selected shall be subjected to all of the tests of this specification. The acceptance quality level(s) (AQL) shall be as specified in Tables I and II.

4.3 TEST CONDITIONS

4.3.1 Atmospheric conditions. - Unless otherwise specified, all tests required by this specification will be made at an atmospheric pressure at 24 to 32 inches of mercury, at a temperature of 25°C ± 10°C, and a relative humidity of 40% or less.

4.4 TEST METHODS

4.4.1 Examination of Products. - The indicators shall be carefully examined to determine conformance to this specification with respect to material, design, defects, workmanship, markings, and all other requirements. N.B. Extreme care should be taken that the atmosphere surrounding the matchbook visual corrosion indicators complies with the relative humidity specification of Section 4.3.1 at all times to prevent permanent damage to the indicators.

4.4.2 Corrosion indication test. - The samples selected from the production lots shall be subjected to destructive testing to determine their effectiveness in identifying corrosive atmospheres. The test temperature and atmospheric pressure should be as specified in Section 4.3.1. The relative humidity, however, should be maintained at 60% $\pm$ 3% (57% R.H. to 63% R.H.) throughout this test. The humidity test chamber will be 20 inches x 12 inches x 12 inches over-all dimensions, or other approved size, and shall contain adequate window area of transparent material. The sample indicator shall be removed from its protective enclosure and placed in the test atmosphere. The test atmosphere should be quiescent throughout the test with no local or general movement of the air, except that mild air circulation may be permitted for a length of time not to exceed 10 minutes at the start of the test. This short period of air circulation is included in the test procedure to allow the relative humidity of the enclosed atmosphere to be brought to the test condition quickly. After the relative humidity has been brought to the required value (60% R.H.), all circulation of air should be stopped and the remainder of the test conducted under quiescent conditions. The test chamber should be equipped with adequate lighting, and the sample shall be located in the test chamber so that the test sample can be examined without requiring its removal from the test chamber and without causing any disturbance of the test atmosphere.

4.4.2.1 Class I, Standard Sensitivity Corrosion Indicator. - After 36 hours exposure to the test atmosphere the indicator being tested will be inspected through the window in the test chamber. At this time less than 10% of the area of the film should show evidence of corrosion (change of color). At the end of 48 more hours (84 hours total elapsed time) the sample indicator will again be inspected through the window in the

test chamber. The indicator(s) being tested should show a change in color over more than 10% of the film area. After 84 hours more exposure to the test atmosphere (168 hours total elapsed time) the corrosion indication test will be concluded, the test chamber opened, and the sample indicator(s) inspected. The test sample(s) should be brown in color over not less than 50% of the area of the metal film.

4.4.2.2 Class 2, Special, Accelerated-Sensitivity, Corrosion Indicator. - After 12 hours exposure to the test atmosphere, the indicator being tested should show some distinct evidence of corrosion. At the end of 24 more hours (36 hours total exposure) the test will be concluded, the test chamber opened and the sample indicator inspected. The test sample should be brown in color over at least 50% of the film area.

4.4.2.3 Test Atmosphere. - The 60% relative humidity will be maintained by means of a potassium hydroxide solution of the correct concentration. Glycerine or sulphuric acid solutions shall not be used. The volume of the solution shall be at least one-fiftieth of that of the volume of the container and the area of the exposed liquid shall be at least three times as large as one side of a cube which would hold the required solution as specified in ASTM Standard E 104-51. The primary standard for determination of relative humidity will be a Hydrodynamics, Inc. hygrometer indicator model No. 15-3000, or equivalent.

4.4.3 Metal Film Thickness Test. - The thickness of the metal film deposited on a sample shall be checked electrically with a fixture especially designed for the purpose. The fixture shall consist of three 0.067 inch diameter pins with hemispherical, gold-plated tips. The three pins shall be held rigidly in a base and shall be insulated electrically from one another. They shall be perpendicular to the base, parallel, and shall be located at the apices of an equilateral triangle with sides $1/2 \pm 1/64$ inch long. The three hemispherical tips shall all lie in one plane which is perpendicular to the axes of the pins. To check the thickness of a deposited metal film, the sample to be checked shall be placed on a smooth, hard, horizontal surface with the metal film facing upward. The three hemispherical tips of the test fixture shall then be pressed against the center portion of the sample with a force of 8 ± 4 ounces and the

electrical resistance between any two tips measured. If this resistance is in the range between 10 and 20 ohms the metal film is of an acceptable thickness.

5. PREPARATION FOR DELIVERY

5.1 Preservation and Packaging. - The packaging, packing, and marking requirements specified herein apply to direct purchases by, or direct shipments to, the government. (See 3.5.6 MIL-P-116.)

5.2 Packaging. - Class 1 indicators shall be packaged Level A, Level B, or Level C, as specified. (See 6.2.)

5.2.1 Level A. - Class 1 indicators shall be packaged in cans conforming to type V, Class 2, Plan B coating of specification PPP-C-96. Unless otherwise specified, the number of indicators per container will be either 25 or 100. The indicators shall be packaged as follows: A bag, or bags, of desiccant, MIL-D-3464, Class 2, shall be placed at the bottom of the container. The desiccant used will be silica gel unless otherwise authorized. The indicators shall then be placed in the container and another bag, or bags, of desiccant placed on top of the indicators. The amount of desiccant used will be as specified in specification MIL-P-116, Section 3.5.6. On top of this top bag, or group of bags, shall be placed a Class 2 matchbook corrosion indicator. This special, accelerated-sensitivity indicator shall be permanently attached to a card on which shall be printed the following:

> NOTICE. -The contents of this container are especially sensitive to moisture and may be permanently damaged by an exposure to the normal atmosphere lasting longer than a few minutes. Attached to this card is a doubly sensitive indicator which will indicate the condition of the contents of this container. If this special indicator shows evidence of a corrosive environment, the contents of this container have been damaged. Close the container tightly and return to the issuing agent. DO NOT ALLOW ANY CONTACT WITH MOISTURE.

5.2.2 Level B. -Class I indicators will be packaged individually in clear, heat-sealable, plastic bags. Each bag will contain one indicator and sufficient desiccant

to maintain a relative humidity within the plastic bag of less than 40% under all foreseeable conditions. The desiccant used will be silica gel powder of a size which will pass through a standard 100 mesh screen. The individually packaged indicators shall then be packaged in cans conforming to type V, class 2, plan B coating of specification PPP-C-96. Unless otherwise specified, the number of indicators per container will be either 25 or 100. The indicators will be packaged as follows: A bag, or bags, of desiccant, MIL-D-3464, Class 2, shall be placed at the bottom of the container. The desiccant used will be silica gel unless otherwise authorized. The individually packaged indicators shall then be placed in the container and another bag, or bags, of desiccant placed on top of the indicators. The amount of desiccant used will be as specified in Specification MIL-P-116, section 3.5.6. On top of this bag, or group of bags, shall be placed a single Class 1 indicator, not packaged in a plastic bag. This indicator shall be permanently attached to a card on which shall be printed the following:

> NOTICE. -The contents of this container are especially sensitive to moisture. Even though the individual indicators are packaged in plastic bags, excessive exposure to the atmosphere may cause permanent damage, since the plastic is not completely impervious to moisture. Attached to this card is a standard indicator which will indicate the extent of possible damage to the enclosed contents. If this indicator shows evidence of having been exposed to a corrosive environment, the contents of this container may have been damaged. Close the container tightly and return to the issuing agent.
>
> DO NOT ALLOW ANY CONTACT WITH MOISTURE.

5.2.3 Level C. -Indicators shall be packaged in accordance with the manufacturer's practice.

5.3 Packing. -Class 1 indicators shall be packed Level A, Level B, or Level C, as specified. (See 6.2.)

5.3.1 Level A. -Class 1 indicators packaged as specified in 5.2 shall be packed in accordance with the Appendix of Specification PPP-C-96 (See also Specifications

JAN-P-103, JAN-P-106, MIL-B-107, JAN-P-108, MIL-L-10547, and MIL-STD-129), as specified for overseas shipment.

5.3.2 Level B. -Class 1 indicators packaged as specified in 5.2 shall be packed in accordance with the Appendix of Specification PPP-C-96 as specified for domestic shipment.

5.3.3 Level C. -Class 1 indicators packaged as specified in 5.2 shall be packed for shipment in such a manner as to ensure safe delivery and acceptance at destination.

5.3.4 Packing of Class 2 Indicators. - Class 2 indicators are to be used only for the purpose of indicating the condition of Class 1 indicators as explained in 5.2.1. There will thus not be any requirement for packing, packaging, or shipment of Class 2 indicators except as discussed in 5.2.1.

5.4 Marking

5.4.1 Unit Container. -Each unit container shall be durably and legibly marked in accordance with Standard MIL-STD-129 and with the following information in such a manner that the marking will not become damaged when any of the containers are opened:

Specification MIL-1
MS Part Number
Quantity
Name of Contractor (if different from manufacturer)
Lot Number
Contract or order number
Date of Manufacture

5.4.1.1 Handling Instructions. -In addition to the information specified in the preceding paragraph the notice given below shall be placed in a conspicuous position on the outside of the container. It shall be durably and legibly printed and placed on the container in such a manner that the marking will not become damaged when the container is opened.

NOTICE. -The contents of this container will be spoiled if they become damp. The contents will be permanently damaged if exposed to the normal atmosphere for a period of time greater than a few minutes. Keep container tightly closed except when removing the contents.

DO NOT ALLOW ANY CONTACT WITH MOISTURE.

5.4.2 Exterior Shipping Container. -Each exterior container shall be marked in accordance with Standard MIL-STD-129.

6. NOTES

6.1 Intended Use.

6.1.1 Class 1 Indicators. -The Class 1 corrosion indicators conforming to this specification are intended for use with Method 11 of Specification MIL-P-116, in which it is necessary to determine that the atmosphere within a package has been maintained at a sufficiently low relative humidity to prevent the start of corrosion on the packaged equipment. The indicators will record the total amount of corrosiveness to which the equipment has been subjected since the package was sealed. The indicators may also be used to indicate the corrosiveness of any other type of atmospheric environment such as might be found in a dehumidified warehouse or a special, dehumidified assembly area. The indicators will also show the existence of any potentially corrosive conditions which might arise in such areas. They are effective in measuring the presence of a potentially corrosive moisture level.

6.1.2 Class 2 Indicators. -Class 2 indicators conforming to this specification are intended only for use in determining the condition of Class 1 indicators when they are packaged Level A in accordance with section 5.2.1 of this specification.

6.2 Ordering Data. -Requisitions, contracts, and orders should specify the following:

a. Title, number, and date of this specification
b. MS part number
c. Quantity
d. Levels of packaging and packing required

6.3 Qualification. -With respect to products requiring qualification, awards

will be made only for such products as have, prior to the bid opening date, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date.

6.3.1 The attention of suppliers is called to this requirement (paragraph 6.3) and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products covered by this specification may be obtained from the Commander, Mobile Air Materiel Area, Packaging Division.

6.3.2 It is to be understood, after receipt of the Letter of Authorization, that samples shall be furnished at no cost to the Government, and that the manufacturer will pay all transportation charges to and from the point where the tests are made. In case of failure of the sample or samples submitted, consideration will be given to the request of the manufacturer for additional tests only after it has been clearly shown that changes have been made in the product which the Government considers sufficient to warrant new tests.

TABLE 1

ACCEPTANCE TESTS, CLASS 1 INDICATOR

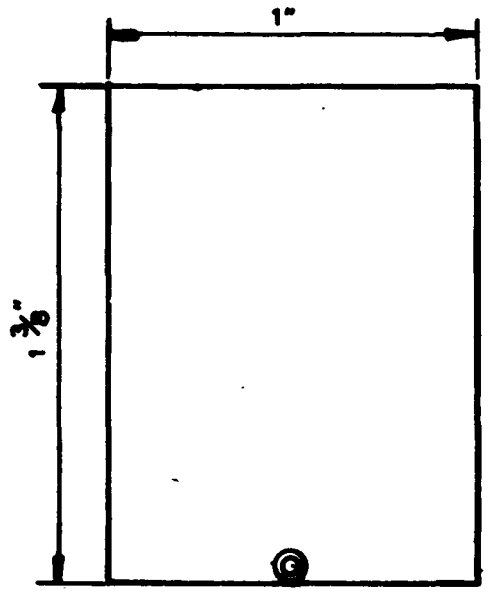
Inspection	Req. Para.	Test Para.	AQL*
Corrosion Indication	3.3	4.4.2 and 4.4.2.1	3.0

TABLE 11

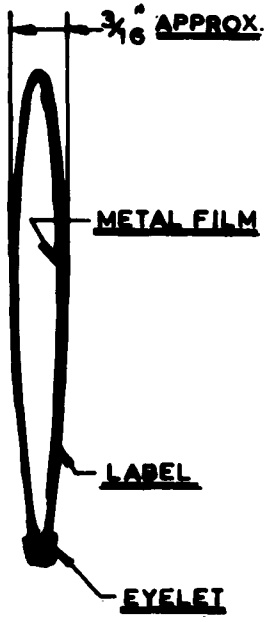
ACCEPTANCE TESTS, CLASS 2 INDICATOR

Inspection	Req. Para.	Test Para.	AQL*
Corrosion Indication	3.3	4.4.2 and 4.4.2.2	3.0

*AQL - Acceptable Quality Level, allowable percentage of defective units, see MIL-STD-105



FRONT VIEW



SIDE VIEW

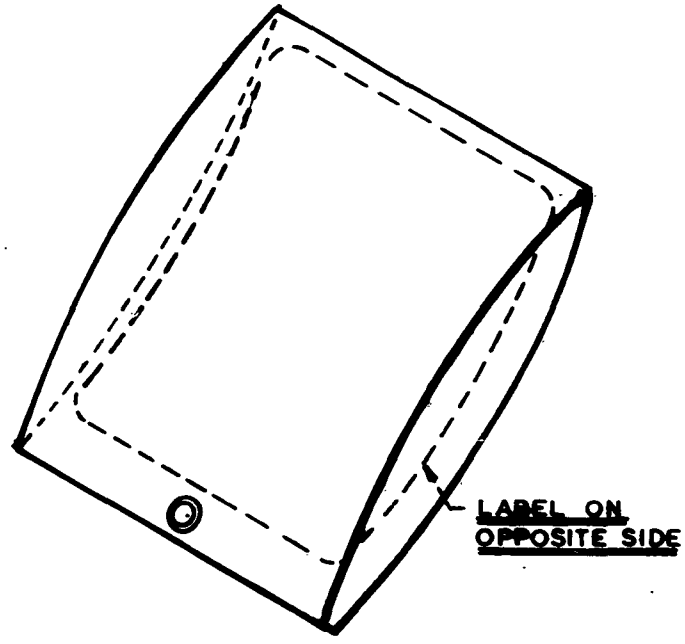


FIGURE 1
MATCHBOOK CORROSION INDICATOR

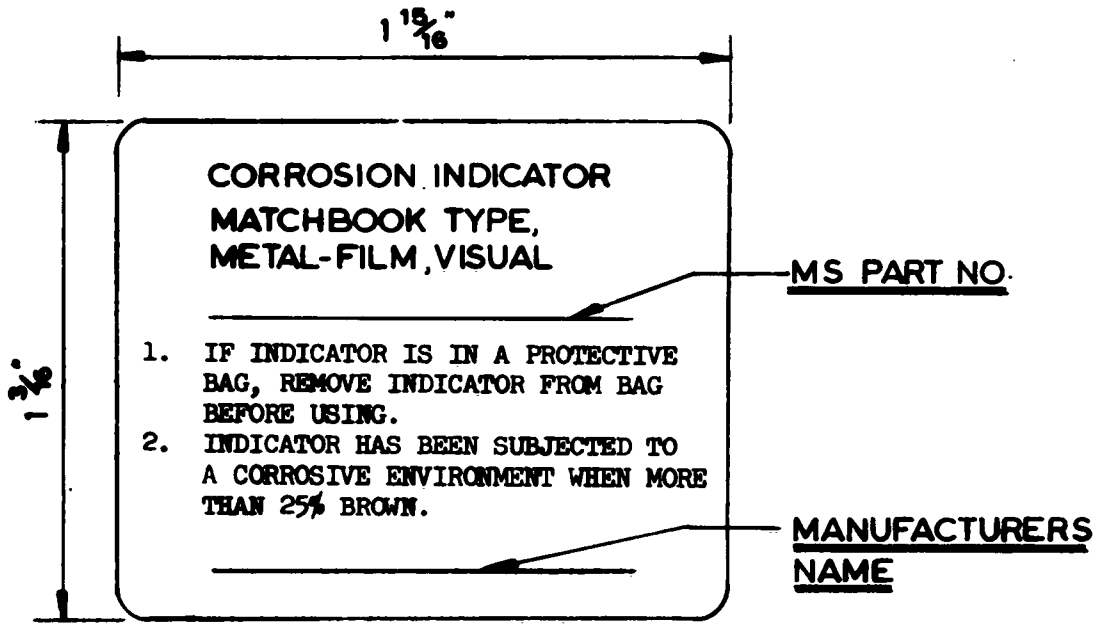


FIGURE 2
LABEL (MATCHBOOK)

MILITARY SPECIFICATION

INDICATOR, CORROSION, PLUG, THIN-METAL-FILM, VISUAL

1. SCOPE

1.1 Scope.-This specification establishes requirements for barrier-mounted, thin-metal-film, corrosion indicators for determining the corrosiveness of the atmosphere contained within a rigid container or a flexible moisture-vapor-proof envelope or bag.

1.2 Classification.-Indicator plugs shall be of a type for mounting with a self-contained locking device or in a threaded boss.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL

TT-P-141	Paint, Varnish, Lacquer, and Related Materials, Methods of Inspection, Sampling, and Testing
PPP-B-585	Boxes, Wood, Wirebound
PPP-B-591	Boxes, Fiberboard, Wood-Cleated
PPP-B-601	Boxes, Wood, Cleated, Plywood
PPP-B-621	Boxes, Wood, Nailed, and Lock-Corner
PPP-B-636	Boxes, Fiber
PPP-C-96	Cans, Metal, 28 Gage and Lighter
PPP-D-729	Drums, Metal, 55-gallon (For shipment of noncorrosive materials)

MILITARY

JAN-P-100	Packaging and Packing for Overseas Shipment (For Weight Contents Not Exceeding 500 pounds)
MIL-B-4229	Boxes, Paperboard, Metal-Stayed
MIL-R-6855	Rubber, Synthetic, Sheet, Molded and Extruded, For Aircraft Application

MIL-B-10377 Box, Wood, Cleated, Veneer Paper Overlaid

MIL-D-3464 Desiccant, Activated (In Bags), for Static Dehumidification and Packaging

MIL-P-7936 Parts and Equipment, Aeronautical, Preparation for Delivery

STANDARDS

MILITARY

MIL-STD-105 Sampling Procedures and Tables for Inspection Attributes

MIL-STD-129 Marking for Shipment and Storage

MIL-STD-130 Identification Marking of U.S. Military Property

MS 33586 Metals, Definition of Dissimilar

(Copies of documents required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

2.2 Other publications.-The following documents form a part of this specification. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

NATIONAL BUREAU OF STANDARDS

Handbook H28 Screw-Thread Standards for Federal Services

American Society for Testing Materials

ASTM Standard E 104-51 Maintaining Constant Relative Humidity by Means of Aqueous Solutions

3. REQUIREMENTS.-The corrosion indicators furnished under this specification shall be products which have been tested and have passed the acceptance tests specified herein.

3.1 Materials.-Materials used in the manufacture of corrosion indicators shall be of high quality and suitable for the purpose intended. The plugs shall be made of metal. The viewing surface shall be clear transparent (acrylic) plastic.

3.1.1 Dissimilar metals.-Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other. Dissimilar metals are defined in MS 33586.

3.1.2 Corrosion.-The various components of the indicators, excepting the sensitized film, shall not corrode nor show deterioration when tested in accordance with 4.3.2. Discoloration without pitting of metal components shall not be considered as failure.
3.1.3 Compatibility.-No gasket or sealing material adjacent to the indicating element shall affect the chemical action of the indicator.

3.2 Design and Construction

3.2.1 General.-The corrosion indicators shall be so designed that the indicating element is freely exposed to the contained atmosphere and only common hand tools are required to install and remove the plugs from rigid or flexible containers. The design shall be such that the exterior gasket seats in a groove in the plug. The depth of the groove shall be not less than 60 percent nor more than 70 percent of the original gasket thickness. The corrosion indicators are particularly sensitive to any type of corrosive environment. Exposure to air with a relative humidity greater than 40 percent, or exposure to any type of corrosive vapors will result in permanent damage. The sensitized surfaces of the indicators should not be exposed to any atmosphere with a relative humidity of more than 40 percent, or which contains any corrosive vapors, after metal film coating, except when placed in use. The metal film can also be permanently damaged if contaminated by any foreign material and the sensitive surface shall be kept clean and unscratched. In particular, the surface shall be kept free from fingerprints and perspiration.
3.2.2 Attachment.-The indicators shall be suitable for attachment in barrier material conforming to Specification MIL-B-131, Class 1 or 2, or in metal containers. The corners of the indicator plug and locknut which will be adjacent to the barrier material shall be so rounded as to preclude puncturing of the barrier material during installation.
3.2.2.1 Size.-Unless otherwise specified, the indicators shall be externally threaded with a 3/4 inch modified National Standard straight-pipe thread as specified in the table titled "Flange and Plug Thread Sizes" of Federal Specification PPP-O-729.

3.3 Performance

3.3.1 Leakage.-There shall be no leakage of the indicators when tested in accordance with 4.3.4.

3.3.2 Moisture vapor transmission rate of indicator plugs.-When tested in accordance with 4.3.5 and calculated as specified in 4.3.5.1, the moisture vapor transmission rate (MVTR) of the test pouch in which the indicator plug has been installed should not exceed 0.07 gram of water per 100 square inches for 24 hours.

3.3.3 Response characteristics - general.-In order that the indicator perform its function, it shall show two distinct phases of response when contacted by a corrosive atmosphere. The first phase shall be an inhibited period, wherein no visible change occurs, and shall be known as the "delay period". The second phase shall consist of a change of color and shall immediately follow the delay period. The delay period is described in paragraph 3.3.4. The color change is described further in paragraph 3.3.5.

3.3.4 Delay period.-The sensitive metal-film surface of the indicator should be treated so as to delay its corrosion or color change for a period of 60 ± 24 hours after exposure to an atmosphere of 60 percent R.H. at 25°C. This built-in delay is necessary to ensure an accurate reading since the atmosphere packaged with the equipment may initially be corrosive. The delay period must be sufficient to protect the corrosion indicator during the packaging pull-down period plus a reasonable handling time.

3.3.5 Color change.-Exposure of the indicator to a corrosive atmosphere shall result in a change of color of the metal-film-coated area from silver-gray to orange-brown. This change will take place progressively over a period of time, starting with small, randomly distributed spots, and spreading to cover the greater portion of the area.

3.4 Details of components.

3.4.1 Indicating element.-The indicating element shall consist of a thin, ferrous-metal film, vacuum coated onto a transparent, acrylic window, paragraph 3.4.2. The film shall be of an appropriate thickness as measured by the method described in paragraph 4.3.9. The metal film shall be coated on the inside face of the Transparent Indicator Window 3.4.2. The details shall be as shown in Fig. 1.

3.4.2 Transparent indicator window.-The transparent indicator window shall be made of cast acrylic plastic sheet which meets the military specification MIL-P-5425, finish A. It shall be optically clear and shall show no discoloration, cracking, delamination, or checking when tested in accordance with 4.3.7. The indicator windows shall resist thermal shock when tested in accordance with 4.3.8. The inside surface of the window

shall be coated with the indicating film 3.4.1. Details of the window are shown in Fig. 1.

3.4.2.1 Viewing area.-Any point on the periphery of the viewing area shall be no less than 5/16 inch from the center of the viewing area.

3.4.3 Gaskets.-Exterior gaskets for sealing the indicator to the container or barrier shall be made of rubber conforming to specification MIL-R-6855, Class II, Grade 60. The gaskets may be either "O" ring or flat type. No additional sealing material shall be required.

3.4.4 Indicator plugs.-The details of the indicator plugs are shown in Fig. 2.

3.5 Identification and marking of product.-Indicators shall be marked in accordance with standard MIL-STD-130.

3.6 Workmanship.-The completed indicators shall show no mold marks, cracks, splits, nor other surface or visible defects that may impair the physical properties or performance characteristics of the indicators in any way.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of tests.-The inspection and testing of the corrosion indicators shall be classified as acceptance tests.

4.1.1 Test conditions.-Unless otherwise specified all tests required by this specification will be made at an atmospheric pressure of 24 to 32 inches of mercury, at a temperature of $25 \pm 10°C$, and a relative humidity of 40% or less.

4.2 Acceptance tests.-Acceptance tests shall consist of:

a. Individual tests.

b. Sampling plan and tests.

c. Production tests.

4.2.1 Individual tests.-Each corrosion indicator shall be subjected to examination as described under 4.3.1.

4.2.2 Sampling plan and tests.

4.2.2.1 Sampling.-The acceptance sampling shall be in accordance with the provisions of Standard MIL-STD-105. Samples selected shall be subjected to all of the tests of this

specification. The acceptance quality level(s) (AQL) will be as specified in Table 1.

4.2.3 Production test.-Each batch of windows which is to be vacuum coated shall contain three inspection samples one inch square or larger of the same material and of the same thickness as the window being coated. These three samples shall be spaced so that one will be located at each end of the vacuum chamber and the third will be located midway between the two ends of the chamber. All of the test samples shall be the same distance from the axis of the chamber as the windows being coated and all shall be held in the same fashion as the windows. In short, they shall be subjected to exactly the same conditions as the windows being coated. Upon the conclusion of the vacuum coating process, the three samples shall be checked for the thickness of the metal film by the method described in paragraph 4.3.9, and if the thicknesses of the three samples are within the acceptable limits the batch shall be considered acceptable.

4.3 Test methods.

4.3.1 Examination of product.-The indicators shall be carefully examined to determine conformance to this specification with respect to material, design, defects, workmanship, markings, and all other requirements for which no tests are specified.

4.3.2 Corrosion.-Three indicators shall be exposed to an atmosphere of 120°F and 95% relative humidity for a period of 150 hours. At the end of the exposure period the indicators, except for the indicating medium, shall not show corrosion. Staining shall not be a cause for rejection. This is a test of the metal parts of which the body of the plug type indicator is made. It is not a test of the indicating surface. Any corrosion of, or damage to, the indicating metal film surface should be ignored when evaluating the results of this test.

4.3.3 Threads.-The indicator threads shall be checked in accordance with National Bureau of Standards Handbook H-28.

4.3.4 Leak Test.-The indicator plugs shall be fitted into an appropriate boss either by screwing into a threaded section or by means of a pressure clamp gripping the base of the plug. A pressure of 10 pounds per square inch gage shall be applied to the side of the boss opposite the indicator plug, and the assembly examined for leakage by noting any pressure drop. The pressure drop may be checked by any suitable gage or by immersion under approximately one inch of water or some other appropriate noncorrosive liquid.

4.3.5 Moisture vapor transmission rate.-Pouches approximately 4 by 6 inches shall be constructed of barrier material conforming to Specification MIL-B-131, Class 1. One pouch shall be required for each sample indicator plug to be tested. An indicator plug shall be properly installed in one wall of each pouch. A 50-gram bag of anhydrous calcium chloride shall be placed in each pouch and the pouches heat sealed. The pouches shall then be conditioned for 24 hours at 100° $\pm$ 2°F and 90 to 95 percent relative humidity. After conditioning, each pouch shall be opened by cutting off one sealed end, the anhydrous calcium chloride bag shall be removed, and a fresh anhydrous calcium chloride bag shall be weighed and inserted in the pouch. The pouches shall then be resealed and exposed for a period of 64 to 68 hours at the above conditions after which they shall be opened and the calcium chloride bags reweighed.

4.3.5.1 Calculations.-The water vapor transmission rate shall be reported in grams of moisture transmitted per 100 square inches of sample area for 24 hours and shall be calculated as shown below. The results on the individual pouches shall be reported.

$$\text{Transmission rate} = \frac{(W_2 - W_1) \times 2400}{T \times A}$$

Where W_1 = Weight (in grams) at the beginning of the exposure period.

W_2 = Weight (in grams) at the end of the exposure period.

T = Exposure period in hours (64 to 68 hours).

A = Area exposed in square inches.

4.3.6 Corrosion indication test.-The indicator plugs selected from the production lot shall be subjected to destructive testing of the indicator windows to determine their effectiveness in detecting corrosive atmospheres. The test conditions shall be as specified in Section 4.1.1 except that the relative humidity should be maintained at 60 $\pm$ 3% throughout the test (see Section 4.3.6.1). The humidity test chamber will be 20 inches x 12 inches x 12 inches over-all dimensions, or other approved size, and shall contain adequate window area of transparent material. The sample indicator to be tested shall be removed from its protective enclosure and placed in the test atmosphere in accordance with the instructions given on the container. The test atmosphere should be quiescent throughout the test with no local or general movement of the air, except that mild air circu-

lation may be permitted for a time not to exceed 10 minutes at the start of the test. This short period of air circulation is included in the test procedure to allow the relative humidity of the enclosed atmosphere to be brought up to the test condition quickly. After the relative humidity has been brought up to the required value (60% R.H.), all circulation of air shall be stopped and the remainder of the test conducted under quiescent conditions. At the end of the first 36 hours, the sample will be inspected. At this time less than 10% of the area of the film should show evidence of corrosion (change of color) Examination of the metal film shall be made through the window from the outside of the test chamber with the aid of an ordinary two-cell flashlight or other equivalent light source. At the end of 48 more hours (84 hours total elapsed time) the sample indicator will again be inspected and at this time more than 10% of the area of the film should show evidence of corrosion. After 84 more hours exposure to the test atmosphere (168 hours total elapsed time) the indicator will again be inspected. At this time, the metal film area should show evidences of corrosion (shall be brown in color) over more than 50% of its surface. This shall conclude the test.

4.3.6.1 Test atmosphere.-The 60% relative humidity will be maintained by means of a potassium hydroxide solution of the correct concentration. Glycerine or sulphuric acid solutions shall not be used. The volume of the solution shall be at least one-fiftieth that of the volume of the container and the area of the exposed liquid shall be at least three times as large as one side of a cube which would hold the required solution as specified in ASTM Standard E 104-51. The test atmosphere shall be allowed to stabilize for three days before testing is begun. The primary standard for determination of relative humidity will be a Hygrodynamics, Inc. hydrometer indicator model No. 15-3000, or equivalent.

4.3.7 Transparency of cover (plastic only).-The viewing face of the humidity indicators should show no discoloration which would impair reading of the indicating element not be in any way affected when exposed for a continuous period of 300 hours in any Atlas twin arc apparatus (method 615.2 of Specification TT-P-141). The water spray shall not be used during the test.

4.3.8 Thermal shock test.-The indicators shall be heated in an oven to 220° $\pm$ 5°F. Water at 34° $\pm$ 3°F shall be dropped on the indicator face with an eyedropper. Cracking or crazing of the transparent face shall be cause for rejection.

4.3.9 Metal film thickness test -The thickness of the metal film deposited on a sample shall be checked electrically with a fixture especially designed for the purpose. The fixture shall consist of three 0.067 inch diameter pins with hemispherical, gold-plated tips. These pins shall be held rigidly in a base and shall be insulated electrically from one another. They shall be parallel to one another, perpendicular to the base, and shall be located at the apices of an equilateral triangle with sides $1/2 \pm 1/64$ inch long. The three hemispherical tips shall all lie in one plane which is perpendicular to the axes of the pins. To check the thickness of a deposited metal film the sample to be checked shall be placed on a smooth, hard, horizontal surface with the metal film facing upward. The three hemispherical tips of the test fixture shall then be pressed against the center portion of the sample with a force of 8 ± 4 ounces and the electrical resistance between any two points measured. If this resistance is in the range between 10 and 20 ohms the metal film is of an acceptable thickness.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging.-The packaging, packing, and marking requirements specified herein apply to direct purchases by, or direct shipments to, the government (see 3.5.6 MIL-P-116).

5.2 Packaging.-Plug-type corrosion indicators shall be packaged Level A, Level B, or Level C as specified (see 6.2).

5.2.1 Level A.-The plug-type corrosion indicators shall be packaged in metal cans conforming to specification PPP-C-96, Type V, Class 2. At the bottom of the can shall be placed a bag (or groups of bags) of desiccant conforming to Specification MIL-D-3464, Class 2. The desiccant used will be silica gel unless otherwise authorized. The indicator plugs shall then be placed in the container and on top of them shall be placed another bag (or group of bags) of desiccant. On top of this bag (or layer of bags) shall be placed a matchbook type visual corrosion indicator, Specification MIL-I-xxxx, Class 2, which is approximately twice as sensitive to corrosion as the indicating elements of the packaged indicator plugs. This special indicator shall be permanently attached to a card on which shall be printed the following:

NOTICE: The contents of this container are especially sensitive to moisture and may be permanently damaged by an exposure to the normal atmosphere lasting longer than a few minutes. Attached to this card is a doubly sensitive indicator which will indicate the condition of the contents of this container. If this special indicator shows evidence of a corrosive environment, the contents of this container have been damaged. Close the container tightly and return to the issuing agent.

DO NOT ALLOW ANY CONTACT WITH MOISTURE.

5.2.2 Level B.-The plug-type indicators shall be packaged individually in clear heat-sealable, plastic bags. Each bag shall contain one indicator and sufficient desiccant to maintain a relative humidity within the plastic bag of less than 40% under all foreseeable conditions. The desiccant used will be silica gel powder of a size which will pass through a 100 mesh screen. The individually packaged indicators shall then be packaged in cans conforming to type V, Class 2, Plan B coating of Specification PPP-C-96. Unless otherwise specified, the number of indicators per container will be either 25 or 100. The pre-packaged indicators shall be packaged as follows: A bag, or group of bags, of desiccant, MIL-D-3464, Class 2, shall be placed at the bottom of the container. The desiccant used will be silica gel unless otherwise authorized. The individually packaged indicators shall then be placed in the container and another bag, or group of bags, of desiccant placed on top of the indicators. The amount of desiccant used shall be as specified in Specification MIL-P-116, Section 3.5.6. On top of this top bag, or group of bags, shall be placed a single matchbook-type visual corrosion indicator, Specification MIL-I-xxxx, Class 1. This matchbook-type indicator shall be permanently attached to a card on which shall be printed the following:

NOTICE: The contents of this container are especially sensitive to moisture. Even though the individual indicators are packaged in plastic bags, excessive exposure to the atmosphere may cause permanent damage, since the plastic is not completely impervious to moisture. Attached to this card is a standard indicator which will indicate the extent of possible damage to the enclosed contents. If this indicator shows evidence of having been exposed to a corrosive environment, the contents

of this container may have been damaged. Close the container tightly and return to the issuing agent.
DO NOT ALLOW ANY CONTACT WITH MOISTURE.

5.2.2.1 Intermediate packaging.-Only identical items shall be included in an intermediate package. Plugs preserved and packaged to meet 5.2.1 or 5.2.2 shall be packaged in containers meeting Specification MIL-B-4229 or PPP-P-636. Unless otherwise specified by the procuring activity, the quantity of unit packages to be included in each intermediate package shall be at the option of the contractor and as governed by the limitations of the containers used.

5.2.3 Level C.-Plug-type corrosion indicators shall be preserved and packaged in accordance with the manufacturer's commercial practice.

5.3 Packing.-The plug-type corrosion indicators shall be packed Level A, Level B, or Level C, as specified (see 6.2).

5.3.1 Level A.-Plug-type corrosion indicators preserved and packaged to meet 5.2.1 or 5.2.2, and complying with 5.2.2.1 shall be packed in domestic type exterior containers meeting Specification PPP-B-591, PPP-B-601, PPP-B-585, PPP-B-621, PPP-B-636, or MIL-B-10377. Exterior containers shall be of minimum cube and tare consistent with the protection required. As far as practicable, exterior containers shall be of uniform shape and size and contain identical quantities. The gross weight of each pack shall be limited to approximately 500 pounds. (Gross weight of Navy procurement only shall be limited to 200 pounds). Containers shall be closed and strapped in accordance with the applicable container specification or appendix thereto.

5.3.2 Level B.-Plug-type corrosion indicators packaged as specified in 5.2 shall be packed in accordance with the Appendix of Specification PPP-C-96 as specified for domestic shipment.

5.3.3 Level C.-Plugs packaged as specified in 5.2.3 shall be packed in accordance with industrial practice to afford protection against damage during direct shipment from the supply source to the first receiving activity for immediate use. Containers shall comply with Consolidated Freight Classification rules or other common carrier regulations applicable to the mode of transportation.

5.4 Physical protection.-Cushioning, blocking, bracing and bolting as required shall be

in accordance with Specifications JAN-P-100 and MIL-P-7936 except that for domestic shipments, waterproofing requirements for cushioning materials and containers shall be waived. Drop tests of specification JAN-P-100 shall be waived when preservation, packaging, and packing of the item are for immediate use.

5.5 Marking.-Interior and exterior containers shall be marked in accordance with Standard MIL-STD-129. The nomenclature shall be as follows: Indicator, Corrosion, Plug, Thin-Metal-Film, Visual.

5.5.1 Handling instructions.-In addition to the information specified in the preceding paragraph, the notice given below shall be placed in a conspicuous position on the outside of the container. It shall be durably and legibly printed and placed on the container in such a manner that the marking will not become damaged when the container is opened.

CAUTION: The contents of this container will be spoiled if they become damp. The contents will be permanently damaged if exposed to the normal atmosphere for a period of time greater than a few minutes. This container positively must not remain open for any longer period than is absolutely necessary for withdrawals. Withdrawals shall be as near as possible to the exact quantity intended to be used. The container shall be tightly resealed immediately after any withdrawal.

5.5.2 Installation instructions.-A label containing the information shown in Fig. 3 shall be permanently attached to the outside of each container. The label shall be durably and legibly printed and shall be attached in such a manner that it will not be detached nor become illegible as a result of normal handling. As an alternative, the instructions may be printed on the outside of the can if the durability and legibility requirements are met. A label as shown in Figure 4 shall be attached to the outside face of the plug indicator.

6. NOTES

6.1 Intended use.-The indicator plugs covered by this specification are intended for insertion in the barriers of method II, Specification MIL-P-116, packages in which it is necessary to determine that the desiccant within a package is sufficiently active to maintain a relative humidity below that at which corrosion might occur, and that non-

corrosive conditions have been maintained within the package since it was originally sealed. The indicator plugs may also be used to monitor the corrosiveness of the environment in any sealed storage chamber, room, or warehouse. Indicator plugs may be placed at different points in the walls of a sealed chamber to indicate the presence of any localized corrosive environment. The indicators will record the corrosion integral (3.3.4) of the atmosphere in which the equipment has remained since the package was sealed. They are effective in measuring the presence of acid vapors in addition to denoting the presence of a potentially corrosive moisture level.

6.2 Ordering data.-Procurement documents should specify the following:

a. Number of indicators per pack.

b. Locknuts as required (see 3.4.4).

c. Selection of applicable levels of preservation and packaging, and packing.

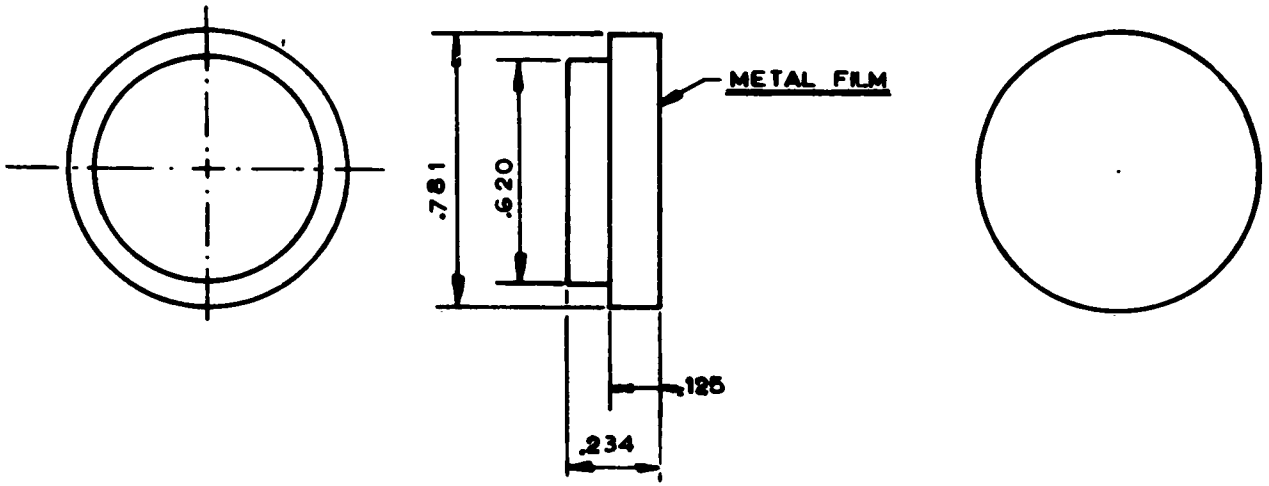
TABLE I

ACCEPTANCE TESTS

Inspection	Req. Par.	Test Par.	AQL*
Workmanship	3.6	4.3.1	10 dphu**
Corrosion of metal parts	3.1.2	4.3.2	4.0
Threads	3.2.2.1	4.3.3	1.0
Leak test	3.3.1	4.3.4	2.5
Moisture vapor transmission rate	3.3.2	4.3.5	2.5
Corrosion indication	3.3.4 and 3.3.5	4.3.6	3.0
Thermal shock	3.4.2	4.3.8	4.0

* AQL - Acceptable Quality Level, allowable percentage of defective units, see MIL-STD-105

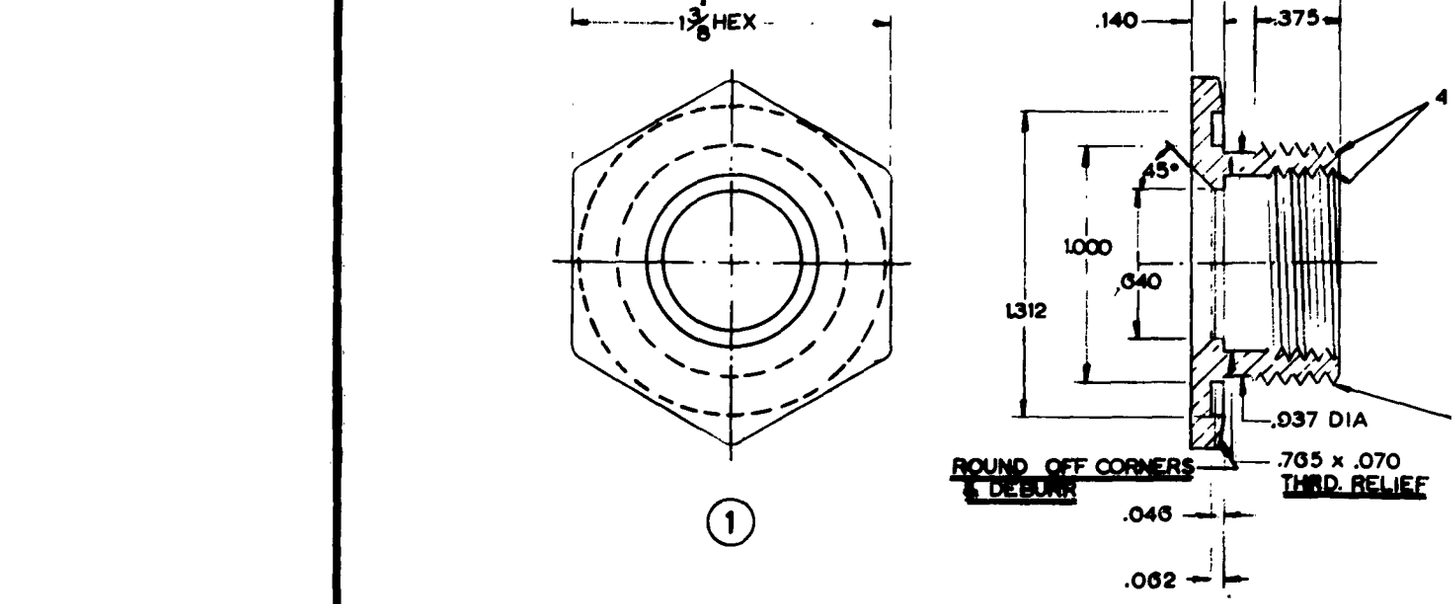
** dphu - Defects per hundred units

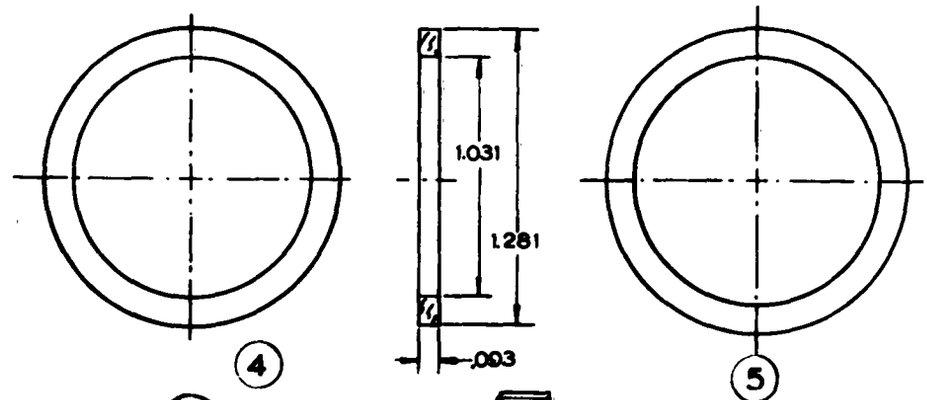


MATERIAL: CAST ACRYLIC PLASTIC SHEET
(MIL-P-5425, FINISH A)

ALL DIMENSIONS ± 1/64"

FIGURE 1
INDICATOR WINDOW


1 3/8 HEX
.630
.140
.375
4
45°
1.000
.640
1.312
.937 DIA
ROUND OFF CORNERS & DEBURR
.765 x .070 THRD. RELIEF
.046
.062
1


1.031
1.281
.093
4
5

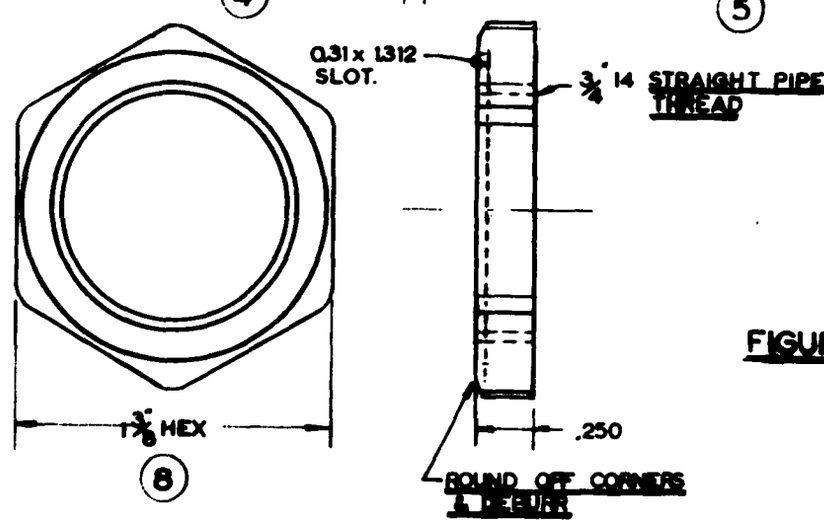
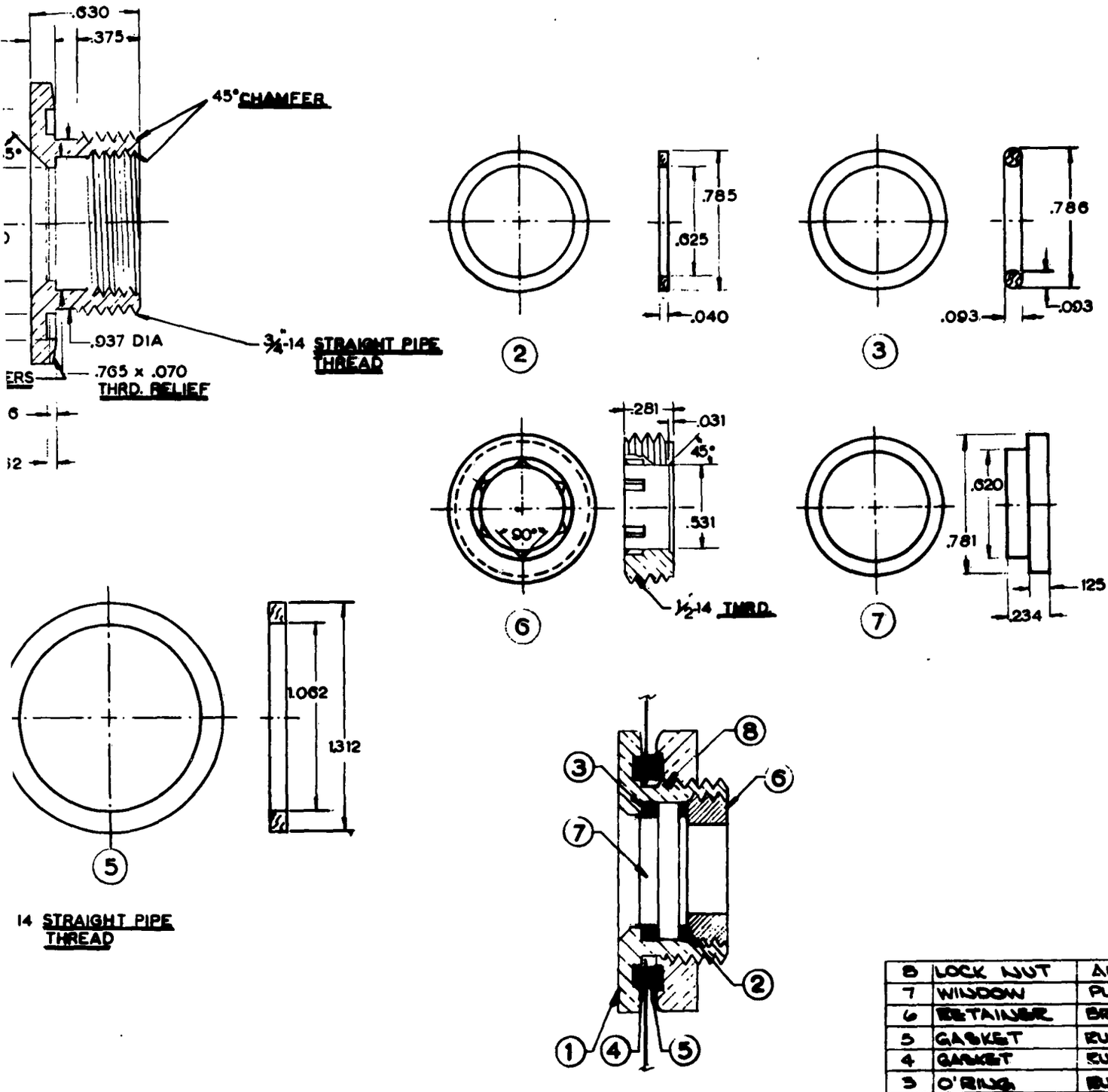

0.31 x 1.312 SLOT.
3/4 14 STRAIGHT PIPE THREAD
1 3/8 HEX
.250
ROUND OFF CORNERS & DEBURR
8

FIGURE 2



8	LOCK NUT	AL.
7	WINDOW	PLASTIC
6	RETAINER	BRASS
5	GASKET	RUBBER
4	GASKET	RUBBER
3	O'RING	RUBBER
2	WASHER	RUBBER
1	BODY	AL.

FIGURE 2 INDICATOR PLUG

2

THIS CONTAINER CONTAINS PLUG-TYPE CORROSION INDICATORS (INDICATOR, CORROSION, PLUG, THIN METAL FILM, VISUAL). THESE INDICATORS WILL BE PERMANENTLY DAMAGED IF EXPOSED TO THE NORMAL ATMOSPHERE FOR A PERIOD LONGER THAN A FEW MINUTES. UNDER NO CIRCUMSTANCES SHOULD ANY OF THE INDICATORS BE ALLOWED TO BECOME DAMP OR BE EXPOSED TO ANY MOISTURE. TAKE OUT ONLY THE ACTUAL NUMBER OF INDICATORS TO BE USED IMMEDIATELY.

THESE INDICATORS SHOULD BE INSTALLED IN VAPOR SEAL BARRIERS AS SHOWN.

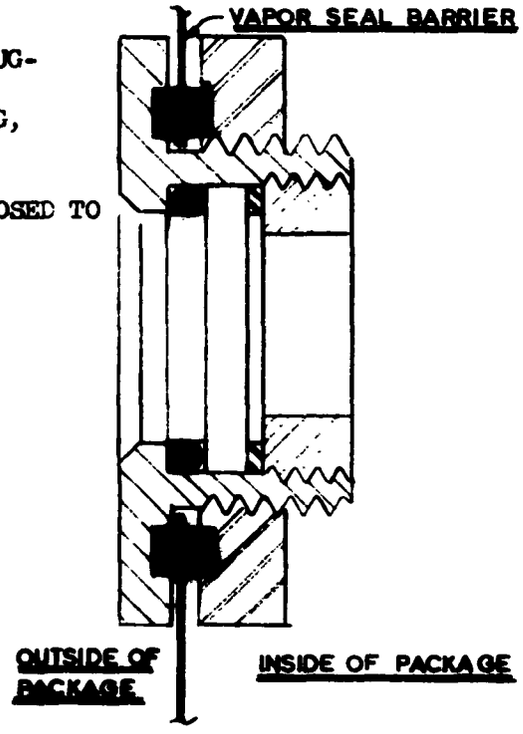


FIGURE 3
PLUG CONTAINER LABEL

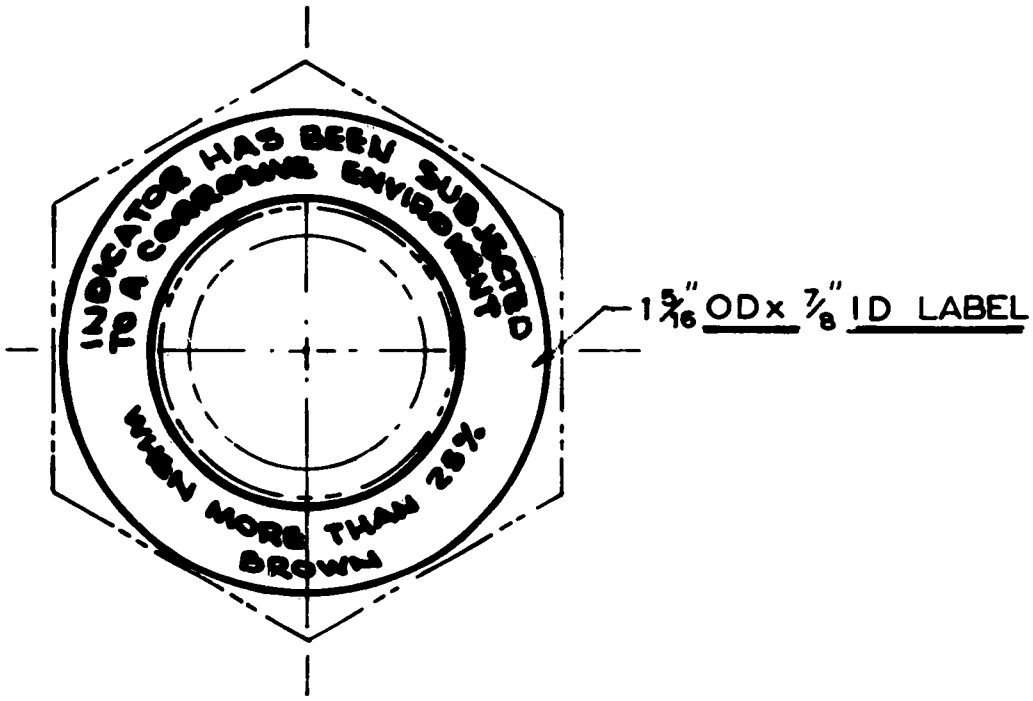


FIGURE 4
PLUG LABEL

MILITARY SPECIFICATIONS
CORROSION INDICATING SYSTEMS
ELECTRICAL RESISTANCE TYPES, FOR PACKAGING

1. SCOPE

1.1 This specification covers two types of corrosion-indicating systems for remotely detecting the presence of a corrosive atmosphere within a sealed package containing equipment in storage, or in a relatively closed environment such as a warehouse or storeroom. The principal components of each system are three in number: a corrosion sensing element, a barrier seal feedthrough, and an indicator or meter. To this group may be added a connecting cord when it is desired to locate the corrosion sensing element at a point which is not adjacent to the barrier or wall of the container, or when it is desired to locate the indicator or meter at some distance away from the barrier seal feedthrough. The indicator may be either of two types: type 1, a corrosion meter, which can be periodically used to check the condition of the indicating element whenever such a check is desired; or type 2, a visual-signal corrosion alarm, which monitors the condition of the sensing element in the packaged environment continuously and flashes a light when the effect of corrosion on the element exceeds a pre-set limit.

1.2 Classification. Electrical resistance corrosion systems shall be of the following types as specified:

Type 1 - Corrosion meter system for spot checking.

Type 2 - Visual corrosion alarm system for continuous monitoring.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, and drawings in effect on date of invitation for bids form a part of this specification:

SPECIFICATIONS

FEDERAL

PPP-B-585	-Boxes, Wood, Wirebound
PPP-B-591	-Boxes, Wood, Cleated Plywood
PPP-B-621	-Boxes, Wood, Nailed and Lock-Corner
PPP-C-96	-Cans, Metal, 28 Gage and Lighter

LLL-B-636 -Boxes, Fiber, Solid (For Domestic Shipment)

L-V-351 -Vinyl Chloride Polymer and Copolymer Rigid Sheets

MILITARY

MIL-B-18 -Batteries, Dry

MIL-P-116 -Preservation, Methods of

JAN-P-108 -

JAN-T-152 -Treatment, Moisture-and-Fungus-Resistant, of Communications, Electronic, and Associated Electrical Equipment

MIL-T-945 -Test Equipment, for use with Electronic Equipment: General Specification

MIL-D-3464 -Desiccants, Activated, Bagged, for Packaging Use and Static Dehumidifications

MIL-C-6054 -Container; Steel Shipping

MIL-F-14072 -Finishes for Ground Signal Equipment

MIL-B-10377 -Box, Wood, Cleated, Veneer, Paper Overlaid

MIL-L-10547 -Liners, Case, Waterproof

STANDARDS

MILITARY

MIL-STD-15 -Electrical and Electronic Symbols

MIL-STD-105 -Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-109 -Military Standard Inspection Terms and Definitions

MIL-STD-129 -Marking of Shipments

MIL-STD-202 -Test Methods for Electronic and Electric Component Parts

MIL-STD-252 -Wired Equipment, Classification of Visual and Mechanical Defects for

DRAWINGS

Signal Corps

SC-D-15800 -Oscilloscope BC-000, Circuit Label

AIR FORCE-NAVY AERONAUTICAL STANDARD DRAWINGS

AN 8025 -Container Assembly-Metal Shipping (6 and 7 Gal.)

(Copies of specifications, standards, and drawings required by contractors in connection with specific procurement functions should be obtained from, or as directed by, the contracting officer. Both the title and identifying number or symbol should be stipulated when requesting copies).

2.2 Other publications.-The following publications, of the issue in effect on the date of invitation for bids, form a part of this specification.

AMERICAN TRUCKING ASSOCIATION

National Motor Freight Classification

(Application for copies should be addressed to the American Trucking Association, 1424 - 16th. Street, N.W., Washington 6, D.C.)

ASSOCIATION OF AMERICAN RAILROADS

Uniform Freight Classification

(Application for copies should be addressed to the Association of American Railroads, 202 Chicago Union Station, Chicago 6, Ill.)

DEPARTMENT OF THE ARMY, THE NAVY, AND THE AIR FORCE

TM-38-230 -Preservation Packaging, and Packing of

NAVEXOS P-938 -Military Supplies and Equipment

AFM 71-1

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington 25, D.C.)

AMERICAN SOCIETY FOR TESTING MATERIALS

ASTM Standard E 104-51 - Maintaining Constant Relative Humidity by Means of Aqueous Solutions.

3. REQUIREMENTS

3.1 The equipment, or assemblies, furnished under this specification shall be products which have been tested and have passed the qualification and inspection tests specified.

3.2 Description, general.-This specification covers a system for remotely detecting the presence of a corrosive atmosphere within a sealed enclosure without opening the enclosure or otherwise inspecting the contents. The presence of a corrosive atmosphere

is determined by means of a corrosion-sensitive element located inside the barrier seal and external electrical devices for ascertaining the condition of the sensing element by measurement of electrical resistance. Contact between the sensing element and the metering devices is made by means of a pair of leads and sealed terminals passing through the barrier wall. The barrier seal terminal design described herein is adapted for use with Method II packs conforming to Specification MIL-P-116. The sensing element may be located anywhere within the enclosure where special precautions against corrosion are desired. The system consists of the following components:

(a) Corrosion Sensing Element, Resistance, described in 3.6.1.

(b) Meter, Corrosion, Electrical Resistance. Either a Corrosion Meter, described in 3.6.2.1, or a Corrosion Alarm, described in 3.6.2.2.

(c) Barrier seal connector, described in 3.6.3.

(d) Cord, connecting, described in 3.6.4.

3.3 Reliability: Equipment will be subjected to continuous use for long periods under varied and severe military service conditions without overhaul and with little, if any, maintenance. To meet these conditions, it is therefore imperative that reliability of operation be considered of prime importance in the design and manufacture of the equipment. The contractor shall employ all methods practicable in the process of design, development, and manufacture which will assure quality and maximum reliability, consistent with the latest developments in the state of the art. In the functional application of parts to equipment circuits, adequate factors of safety shall be provided by suitable deratings from the part specifications values in order to assure high equipment reliability under all service conditions. The design of the Meter, Corrosion, Electrical Resistance, shall include all possible features which will result in reliable and stable operation with reduced requirements for adjustment and alignment.

3.4 Parts, materials, and processes, general: In addition to any requirement of this specification, covering parts, materials, and processes used in the indicator, such items shall conform to Specification MIL-T-945 including the selection requirements therein, with the exception that paragraph 3.48.2 shall not apply.

3.5 Performance, System. Response Characteristics - General: In order that the system described herein perform its function, it shall show two distinct phases of response after the sensing element is contacted by a corrosive atmosphere. The first phase shall be an

inhibited period, during which little or no change in the condition of the element over that observed for a non-corrosive atmosphere shall occur. This shall be known as the "delay period". The second phase shall consist of a relatively rapid change in the read-out from the "non-corrosive" indication to the "corrosive" indication. These two responses are described in detail in the following sections.

3.5.1 Delay Period: The system shall be designed so that no change in the indicated condition is observed over a period of 60 ± 24 hours after initial exposure of the sensing element to an atmosphere at 60% R.H. and 25°C, subsequent to storage of the element in a desiccated container (R.H. less than 5%). The delay period will be somewhat shorter if the average relative humidity is higher than 60%, and longer if the relative humidity is lower. This delay period is required so that the system will not be rendered useless by response to any initially corrosive atmosphere present in a package immediately after sealing. Thus the delay period must protect the sensing element during the pull-down period.

3.5.2 Response Change: Continued exposure of the sensing element to a corrosive atmosphere subsequent to the delay period shall cause either (a) a needle to move from the "GOOD" region to the "BAD" region of the scale, or (b) a light to begin to flash, (depending on the type of external indicating device used), within a few days after the expiration of the delay period. This change shall be based on an increase in the electrical resistance of the sensing element as a result of the cumulative effect of contact with the corrosive atmosphere. This effect, and the external indication, shall be permanent and non-reversible.

3.6 Detailed construction.-Components.

3.6.1 Corrosion Sensing Element, Electrical Resistance: The element shall consist of a corrosion-sensitive metal film deposited on a piece of rigid vinyl chloride plastic sheet (see Figure 1). The vinyl plastic shall conform to Federal Specification L-V-351, Class 3. The vinyl plastic backing piece shall support the corrosion sensing metal film and the terminals. The terminals shall be suitably formed to provide a good physical and electrical connection to the barrier seal feedthrough (See 3.6.3). The spacing and dimensions of the terminals shall be as shown in Figure 1. The metal film element, when uncorroded, shall have an electrical resistance between 10 and 100 ohms, inclusive, as measured

between the terminal pins. The corrosion sensitive metal film surface of the indicator shall be treated so as to delay its change of electrical resistance for a period of 60 $\pm$ 24 hours after exposure to an atmosphere of 60% R.H. at 25°C.

3.6.1.1 Handling precautions: The operation of the corrosion sensing element will be impaired if any moisture condenses on it, or if it is exposed to an atmosphere with a relative humidity in excess of 40% for more than a few minutes prior to use. The damage, unless it is excessive, will be undetectable. It will result in an indeterminate reduction in the built-in delay period which serves to protect the sensing element during the package pull-down period. As the extent of this form of damage cannot be detected, and as it could not be corrected even if it could be detected, the only safe course is to discard the sensing element if there is any question regarding its condition.

3.6.2 Meter, Corrosion, Electrical Resistance.

3.6.2.1 Corrosion Meter: The meter shall transform the ohmic resistance of the sensing element to a reading on a scale which shall indicate the condition of the element. The meter shall operate from a self-contained battery. The scale shall be divided into two main regions: one marked "GOOD", and one marked "BAD". In addition, the scale shall have a small area between GOOD and BAD marked "METER OK". See Figure 2 for details. These regions shall be of different colors. The "BAD" section shall be colored red, the "GOOD" section shall be colored green and the "METER OK" section shall be colored white. The scale shall be clearly and distinctly marked so that unskilled operating personnel can use the instrument without danger of misunderstanding or misapplication. The meter shall have a 2-foot length of number 16, flexible, 2-conductor, electrical cord permanently attached to it. The free end of the cord shall be equipped with an electric terminal in accordance with the requirements given in Figure 3. The meter shall be enclosed in a seamless anodized aluminum case with a removable, seamless, anodized aluminum top as shown in Figure 4. The meter shall be compact and shall be easily held in one hand. The weight of the meter assembly, including attached cord and terminal, shall be less than one pound. Operating instructions shall be printed on the side of the meter in a clear and legible manner. The printing shall be such as to be relatively permanent and shall resist all normal wear and abrasion so that the instructions will remain readable throughout the useful life of the meter.

3.6.2.1.1 Check circuit. The meter shall be provided with a built-in check circuit to check whether the battery and circuitry are in suitable condition to permit operation as specified. The meter shall also be equipped with a screwdriver adjustable calibration device to enable the pointer to be adjusted to the designated position on the scale when the check switch is actuated and the battery is in good condition. As the battery ages, the potential will decrease slightly, and it will occasionally be necessary to recalibrate the meter to make the needle point to the METER OK portion of the dial when the PUSH TO CHECK METER button is depressed. When it is no longer possible to make the needle point to the METER OK portion with the meter calibration screw, the battery is spent and should be replaced.

3.6.2.1.2 Short circuit test: The meter shall be equipped with a short circuit test circuit. It shall be possible to determine whether or not there is a short in the external circuit (the external leads connected to the corrosion sensing element) by actuating a switch on the face of the meter container. If there is a short in the external circuit this shall be shown by the indicating needle. The needle shall point to the BAD portion of the scale if there is a short, and to the GOOD portion of the scale if there is not a short in the external circuit.

3.6.2.2 Visual Corrosion Alarm: The visual corrosion alarm shall continuously monitor the condition of the corrosion element. When the resistance of the element increases to 1800 ± 100 ohms, the alarm shall cause a self-contained neon lamp to flash. The alarm shall be designed so that the flashing action will continue for a period of three months without attention, so long as the resistance of the sensing element is at or above 1800 ohms. The alarm shall operate from self-contained batteries. It shall have a 2-foot length of 2-conductor cord permanently attached to it, and the free end of the cord shall be equipped with an electric terminal in accordance with the requirements given in Figure 3. The alarm shall be enclosed in a seamless, anodized aluminum case with a removable seamless anodized aluminum top as shown in Figure 5. The alarm shall be compact and shall be easily held in one hand. The weight of the alarm assembly, including batteries and attached cord, shall be less than 2-1/2 pounds. Operating instructions shall be printed on the side of the container in a clear and legible manner. The printing shall be such as to be relatively permanent and shall resist all normal wear and abrasion so

that the instructions will remain readable throughout the useful life of the meter.

3.6.2.2.1 Check circuit: The alarm shall be provided with a built-in check circuit to check whether the batteries and circuitry are in suitable condition to permit the proper operation of the alarm system.

3.6.2.2.2 Short circuit test: The alarm shall be equipped with a short circuit test circuit. It shall be possible to determine whether or not there is a short in the external circuit (the external leads connected to the corrosion sensing element) by actuating a switch on the face of the alarm container. The switch on the face of the visual alarm shall be a three-position rotary switch which shall be spring loaded so that it will return to the center position whenever the actuating torque is released. The center position shall be the normal operating position. The positions on the right and left shall be marked SHORT and CIRCUIT. To test for a short in the external circuit, first twist the handle of the knob marked TEST to the position marked CIRCUIT to make certain that the internal circuit and batteries are in good condition. If they are, the light will start to flash and continue flashing until the knob is released. Then twist the knob to the position marked SHORT. If there is a short in the external circuit, the light will start to flash and continue flashing until the knob is released.

3.6.2.3 Battery requirements.

3.6.2.3.1 Battery requirements, corrosion meter: The batteries shall conform to Specification MIL-B-18. The contractor shall, in the design of the meter, submit the electrical and physical requirements for batteries to the Contracting Officer and shall obtain approval for the batteries to be used. The meter shall perform for 50,000 observations lasting ten seconds each with ten-second intervals between readings, at 70°F.

3.6.2.3.2 Battery requirements, corrosion alarm: The batteries shall conform to Specification MIL-B-18. The contractor shall, in his design of the corrosion alarm, submit the electrical and physical requirements for batteries to the Contracting Officer and shall obtain approval of the batteries to be used. One set of batteries, and the corresponding circuit, shall be such as to operate the flashing light continuously for a period of three months at 70°F should the atmosphere in which the element is placed become corrosive. The other set of batteries, and corresponding circuit, shall be such as to prevent the light from flashing for a period of 14 months at 70°F as long as the element

remains in a non-corrosive atmosphere.

3.6.2.4 Adaptation for Tropical Use.

3.6.2.4.1 Treatment of assembled equipment. The assembled indicator shall be treated in accordance with Specification JAN-T-152 unless both of the following conditions are met:

(a) Each component part and subassembly meets one of the following:

(1) It is furnished under an individual, detailed Government document (specification, standard, drawing, etc.) which is applicable on contract.

(2) It does not incorporate any material listed in 3.6.2.4.2 unless the material has been given the treatment specified in Specification MIL-T-945 or a treatment approved by the Contracting Officer.

(3) It does not comply with (1) or (2) above but its use has been approved by the Contracting Officer for the particular application.

(b) The finish of the interior of the equipment meets the requirements of Specification MIL-F-14072.

3.6.2.4.2 Materials not resistant to moisture and fungi. The following materials are considered not resistant to moisture and fungi:

(a) Cellulose, regenerated.

(b) Cotton.

(c) Cork.

(d) Felt, hair or wool.

(e) Jute.

(f) Leather

(g) Linen.

(h) Paper, paperboard, cardboard, organic fiberboard, vulcanized fiber.

(i) Thermosetting plastic materials using cotton, linen, or wood-flour as a filler or base.

3.6.2.4.3 Statement of treatment. The contractor shall submit, to the Contracting Officer for approval, a statement describing in detail the materials to be treated and the

treating materials and processes that are proposed for use. This statement shall include those statements required by Specification JAN-T-152, as applicable.

3.6.3 Barrier seal feedthrough. The barrier seal feedthrough is a device which mounts in the moisture barrier of a package to provide proper electrical connection between the element on the inside of the package and the indicator on the outside so that an airtight and moisture tight connection is maintained at the barrier. The connector shall conform to the physical characteristics shown in Figure 6. The connector shall provide proper support for direct mounting of the element and proper electrical connection to the cord (3.6.4).

3.6.3.1 The barrier seal feedthrough shall withstand a pressure differential of three-eighths (3/8) pounds per square inch without leakage when installed in a Method IIa package conforming to Specification MIL-P-116 as tested in 4.11.1.

3.6.3.2 The barrier seal feedthrough shall withstand a pressure differential of five (5) pounds per square inch when installed in a Method IId package conforming to Specification MIL-P-116 as tested in 4.11.2.

3.6.3.3 The barrier seal feedthrough shall be capable of performing in accordance with this specification after subjection to the life test described in 4.9.

3.6.4 Cord. A suitable two conductor cord having a suitable terminal on each end as shown in Figure 7 shall be provided, if specified. This cord shall be used to connect the indicator to the barrier seal connector if it is desired to locate the indicator some distance away from the barrier seal feedthrough. Cords shall be of the length specified in the contract or order. The same cord shall be used if it is desired to locate the corrosion alarm or the corrosion meter at an appreciable distance from the barrier seal connector.

3.6.5 Types of assembly. The type, or types of assembly to be furnished (element, barrier seal connector, or cord) shall be as stated in the proposed request and contract.

3.7 Service conditions: The corrosion indicating equipment (corrosion meter and corrosion alarm) shall meet the following service conditions:

3.7.1 Equipment-reading environment. The equipment shall not require any warm-up period and, excepting the corrosion sensing element, it shall meet the requirements of this specification while subjected to the following conditions successively or in any combination likely to be encountered in world-wide operation:

(a) Temperature. Any temperature in the range of -18°C to +66°C.

(b) Relative humidity. Any relative humidity up to 100 percent.

3.7.2. Equipment - nonreading environment: The equipment, when packaged for shipment, shall comply with the requirements of 3.7.1 after subjection to any of the following conditions successively or in any combination encountered during world-wide storage or transit:

(a) Temperature. Any ambient temperature ranging from -60°C to +70°C.

(b) Relative humidity. Relative humidity up to 100 percent including condensation caused by temperature changes.

(c) Vibration. Except for internal resonance of parts and subassemblies specified herein, the corrosion sensing element and barrier seal feedthrough shall have no mechanical resonance below 55 cycles per second when shock mounts, if any, are blocked or removed.

(d) Bounce. The element and barrier seal feedthrough shall be so designed that they will withstand repeated rough handling encountered in use, transportation, and storage. There shall be no damage, other than surface abrasion or minor mechanical damage which does not impair the operation or accuracy of the equipment, after being tested in conformance with 4.16.

3.8 Adjustment and repair: The meters, either the corrosion meter or the corrosion alarm, shall be so constructed that parts, terminals, wiring, etc., are accessible for circuit checking, maintenance, and replacement with minimum disturbance to other parts and wiring. No special tools or instruments shall be required for normal servicing.

3.9 Circuit diagram. A circuit diagram shall be furnished with each corrosion meter or alarm. The diagram shall be printed clearly on a label which shall be attached with adhesive to the inside of the case in such a manner that it shall be easily readable when the case is open. The circuit diagram (schematic, wiring, and cabling) shall be suitable for use by maintenance personnel. Graphical symbols on schematic diagrams shall conform to Standard MIL-STD-15. Schematic wiring diagrams will conform to the sample drawings shown in drawing SC-D-15800.

3.10 Interchangeability: Corresponding assemblies, replaceable subassemblies, and

replaceable parts shall be physically and functionally interchangeable as units without modification thereof, or of other items with which the units are used. (See 4.17). When dimensions, ratings, characteristics, etc., are not specified, the manufacturer's design limits shall be used to determine compliance with the foregoing. If the contractor is in doubt as to whether a particular subassembly or part is to be considered replaceable, the Contracting Officer shall be consulted.

3.11 Operating instructions. The operating instructions shall be printed on the side of the case, (Figure 4-A and Figure 5-A). Battery replacement shall be as indicated on the schematic diagram located inside the case.

3.12 Preconditioning. The Corrosion Meter, Electrical Resistance, or Corrosion Alarm, shall meet the inspection of section 4.11, without further processing.

3.13 Workmanship. The equipment shall be manufactured and assembled in a thoroughly workmanlike manner, in accordance with the applicable portions of Specification MIL-T-945:

General requirements for plastic materials and plastic parts.

Wiring and cabling, including:

- Slack
- Protection
- Clearance
- Splicing
- Connections, general
- Grounding, general
- Shielding on wire and cable
- Flux and cleaning agents for soldering
- Process for soldering
- Cleaning of equipment
- Riveting
- General requirements for securing of parts
- Self-tapping screw

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection, general

4.1.1 Definitions. Standard MIL-STD-109 shall be used as applicable for definition of inspection terms used herein.

4.1.2 Classification of inspection. Inspection shall be classified as follows:

(a) Qualification inspection. (See 4.4)

(b) Acceptance inspection. (See 4.5)

4.2 Test conditions: All measurements and tests shall be conducted under the conditions stated herein. Unless otherwise specified all tests of corrosion sensing elements required by this specification should be made at an atmospheric pressure of 24 to 32 inches of mercury, at a temperature of 25 $\pm$ 2°C, and a relative humidity of 40% or less. Tests of meters, cords, and barrier seal connectors required by this specification should be made at an atmospheric pressure of 24 to 32 inches of mercury and at a temperature of 25 $\pm$ 10°C and any relative humidity. Where tests are made with atmospheric pressure or temperature substantially different from the above values, proper allowance shall be made for the change in instrument reading.

4.3 Test equipment and inspection facilities: Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required acceptance tests. The manufacturer shall establish adequate calibration of test equipment to the satisfaction of the Government.

4.4 Qualification inspection: Qualification inspection shall be conducted at a laboratory approved by the Air Force. This inspection shall be as stated in 4.4.4.

4.4.1 Qualification sample: Qualification samples of the equipment or assemblies covered by this specification for which qualification approval is desired, shall be submitted in the following quantities:

(a) Corrosion Sensing Elements -- 25

(b) Meters -- 2 each of type or types specified

(c) Cords -- 10

(d) Barrier seal feedthroughs -- 10

4.4.2 Compliance with specified requirements.

4.4.2.1 Qualification samples shall meet specified requirements, shall be made by

tools and methods that will be used for quantity production, and shall be accompanied by a statement to that effect.

4.4.2.2 Approval of qualification samples shall not be considered as a waiver of any specified requirement. After being released to the contractor, qualification samples of the indicators, cords, and barrier seal connectors to be offered as units on contract shall be refabricated by the contractor, if necessary, to meet specified requirements. Qualification samples of the elements will not be offered as production units.

4.4.2.3 When deviation from 4.4.2.1 is unavoidable, the qualification samples may be submitted for approval provided that the accompanying statement describes in detail each nonconforming feature, reason therefore, and manner in which it will be corrected in production of equipment on contract.

4.4.3 Engineering data: Qualification samples of the corrosion sensing element, meter, barrier seal feedthrough, and cord will be accompanied by certified engineering data showing compliance with specified performance. The engineering data will be comprised of an engineering report giving test procedure, observations, and other data, calculations, test results, and essential details of the testing equipment (manufacturer's model, serial number, date of calibration, and the like). The following specific information shall be furnished:

(a) Graphs and test data which show the resistance of the corrosion sensing element versus time at 60 $\pm$ 2% relative humidity throughout the test period.

(b) Graphs and test data which show the relative humidity and the temperature versus time in the test chamber throughout the test period.

4.4.4 Test routine.

4.4.4.1 Qualification inspection: Qualification inspection shall consist of the inspection specified in Table I. Other nondestructive inspections of qualification samples may be performed to determine compliance with specified requirements.

4.4.4.1.1 Corrosion Sensing Elements: Qualification inspection of corrosion sensing elements shall be performed first in the following order:

(1) Visual

(2) Interchangeability

(3) Vibration

(4) Bounce

(5) Electrical characteristics

4.4.4.1.2 Barrier seal connector and cord: Qualification inspection shall be performed in the sequence indicated in Table I.

4.4.4.1.3 Meter, corrosion meter: Qualification inspection may be performed in any sequence deemed necessary.

4.4.4.1.4 Meter, corrosion alarm: Qualification inspection shall be performed in any sequence deemed necessary.

4.4.5 Defectives: Defective units in excess of those allowed (see Table I) will be cause for refusal to grant qualification approval.

4.5 Acceptance inspection: Acceptance inspection shall include group A and group B inspection as specified in 4.5.1 through 4.5.3.2. Group B inspection shall normally be performed on inspection lots that have passed group A inspection or on samples selected from units that have been subjected to, and met, the group A inspection. However, the order may be varied when the Government considers it more practicable to select separate samples for group B inspection. Each meter which will be subjected to group A or group B inspection shall be preconditioned after final assembly. (See 3.12).

4.5.1 Group A inspection: Group A inspection (including sampling) shall conform to Table II and Standard MIL-STD-105.

4.5.2 Group B inspection: Group B inspection shall conform to Table III and Standard MIL-STD-105.

4.5.2.1 Sampling for inspection of equipment: The samples of corrosion sensing elements and barrier seal feedthroughs for group B inspection as listed in Table III shall be selected without regard to their quality. These samples shall be selected from each 10,000 units produced or each month's production, whichever is less, without regard to their quality. Two meters shall be selected without regard to their quality from each 100 units produced, for group B inspection.

4.5.2.2 Noncompliance: If a sample fails group B tests, the manufacturer shall take corrective action on the processes and all units of product which were manufactured

with the same conditions, materials, processes, etc. and are considered subject to the same test failure. Government inspection may be discontinued, at the option of the procuring agency, technical bureau, or service, until a sample produced by the corrected process has been subjected to and has passed the group B tests failed by the preceding sample. Units of product subsequently submitted for Government inspection shall incorporate the corrective action, unless this requirement is waived temporarily by the procuring agency, technical bureau, or service.

4.6 Inspection standards.

4.6.1 Resistance measurement. All resistance measurements shall be made to an accuracy of 5% or better. Resistance measurements shall be made with any standard type of measuring device which will meet the required accuracy.

4.6.2 Relative humidity standard. The primary standard for determination of relative humidity will be a Hygrodynamics, Inc. hygrometer indicator model No. 15-3000, or equivalent.

4.7 Visual and mechanical inspection. Equipment shall be examined for the major and minor defects listed in Standard MIL-STD-252 and for the following:

a. Element. The appearance of cracks in the corrosion sensitive portion, damage to conducting grid, loose terminals, and deviation from required dimensions.

b. Meter. Deviations from proper spacing and size of terminals of lead wire, from proper operation of controls, from proper operation of meter or flashing alarm, and from correctness of physical characteristics described in 3.6.2 through 3.6.2.2.

c. Cord. Deviations from proper spacing and size of terminals, over-all length, and other characteristics described in 3.6.4.

d. Barrier seal connector. Deviations from proper spacing and size of terminals and correctness of physical characteristics described in 3.6.3.

4.8 Test procedure for corrosion sensing element. The samples selected from the production lots shall be subjected to destructive testing to determine their effectiveness in identifying corrosive atmospheres. The test temperatures and atmosphere shall be as

specified in Section 4.2. The relative humidity, however, shall be maintained at 60% ± 3% (57% R.H. to 63% R.H.) throughout this test. The humidity test chamber shall be 20 inches x 12 inches x 12 inches over-all dimensions or other approved size, and shall contain adequate window area of transparent material. The sample corrosion sensing element shall be removed from its protective enclosure and placed in the test atmosphere in accordance with the instructions given in the technical manual. The test atmosphere should be quiescent throughout the test with no local or general movement of the air, except that mild air circulation may be permitted for a length of time not to exceed 10 minutes at the start of the test. This short period of air circulation is included in the test procedure to allow the relative humidity of the enclosed atmosphere to be brought to the test condition quickly. After the relative humidity has been brought to the required value (60% R.H.), all circulation of air shall be stopped and the remainder of the test should be conducted under quiescent conditions. The electrical resistance of the element should be measured at intervals of no less than two hours, or may be monitored continuously with suitable automatic equipment.

The plotted curve of resistance versus time shall lie between the extremes as shown in figure 8.

4.8.1 Test atmosphere: The 60% relative humidity shall be maintained by means of a potassium hydroxide solution of the correct concentration. Glycerine or sulphuric acid solutions shall not be used. The volume of the solution shall be at least one-fiftieth of that of the volume of the container and the area of the exposed liquid shall be at least three times as large as one side of a cube which would hold the required solution as specified in ASTM Standard E 104-51. The primary standard for determination of relative humidity shall be a Hygrodynamics, Inc. hygrometer indicator Model No. 15-3000, or equivalent.

4.9 Battery life.

4.9.1 Battery life, corrosion meter: The meter shall be checked to assure compliance with the requirements of 3.6.2.3.1.

4.9.2 Battery life, corrosion alarm: The alarm shall be checked to assure compliance with the requirements of 3.6.2.3.2. As an alternative to testing, a set of calculations, based on circuit characteristics as determined by test and certified test data supplied by the battery manufacturer, may be submitted in satisfaction of this requirement.

4.10 Meter calibration tests.

4.10.1 Corrosion meter calibration tests.

4.10.1.1 Corrosion meter calibration at +25°C: With the meter maintained at 25°C ± 2°C depress the button marked "PUSH TO CHECK METER" and, if necessary, adjust the position of the needle by means of the adjusting screw to point to the section of the scale marked "METER OK" when the button is depressed. Release the button and connect a 1500 ohm ± 10% electrical resistor across the terminals at the end of the meter cord. The meter needle shall point to the "METER OK" position of the scale or slightly to the left in the red portion marked "BAD". Replace the 1500 ohm resistor with a 10 ohm resistor. The meter needle shall now point to the right-hand edge of the "GOOD" portion of the scale.

4.10.1.2 Corrosion meter calibration at +5°C and +40°C: Repeat the test of 4.10.1.1 with the meter at 5°C and 40°C respectively. The meter shall test satisfactorily at both temperatures.

4.10.1.3 Corrosion meter short circuit test: Connect a 10 ohm electrical resistor across the terminals at the end of the meter cord. Depress the button marked "SHORT CIRCUIT TEST". The meter needle shall point to the portion of the dial marked "GOOD". Connect the terminals at the end of the meter cord with a short piece of copper wire and again depress the "SHORT CIRCUIT TEST" button. The meter needle shall point to the portion of the dial marked "BAD". Replace the short piece of wire with a 5.0 ohm resistor and depress the SHORT CIRCUIT TEST" button. The needle shall now point to the dividing line between the portion of the dial marked "GOOD" and the portion marked "BAD" (i.e., to the portion marked "METER OK").

4.10.2 Corrosion alarm tests.

4.10.2.1 Visual corrosion alarm tests at 25°C: With the alarm meter maintained at 25°C ± 2°C and with the terminals at the end of the cord attached to the alarm meter shorted (connected together), the light shall not flash. Turn the selector switch to the position marked "CIRCUIT TEST" and hold it there. The light shall flash and continue flashing until the switch is released. Place a variable resistance across the terminals at the end of the cord connected to the corrosion alarm and allow the selector switch to return to neutral. With the variable resistance adjusted to 800 ohms the light shall not flash. Increase the

variable resistance to 2000 ohms and the light shall flash.

4.10.2.2 Visual corrosion alarm tests at +5°C and +40°C. Repeat the test procedure of 4.10.2.1 with the alarm meter maintained at 5°C and 40°C respectively.

4.10.2.3 Visual corrosion alarm short circuit test. Place a three ohm resistor across the terminals at the end of the cord connected to the corrosion alarm. Turn the selector switch to the "SHORT TEST" position and hold it there. The light shall flash and continue flashing until the switch is released. Replace the three ohm resistor with a 10 ohm resistor. Turn the selector switch and hold it as before. The light shall not flash.

4.11 Barrier seal feedthrough tests.

4.11.1 Tests with Method IIa barrier material.

(a) Mount the feedthrough in a piece of Method IIa barrier material. Place the barrier material and feedthrough in a test jig so that the external part of the barrier seal feedthrough is covered with water to a depth of 1/4 inch. Apply air pressure of three-eighths pound per square inch to the internal side of the feedthrough. Examine the various parts of the feedthrough for the presence of recurring air bubbles indicating air leakage. If none are found, the barrier seal feedthrough meets the requirements of 3.6.3.1.

(b) Repeat the test of 4.11.1a by inverting the barrier and barrier seal feedthrough in the test jig and by applying the pressure to the external side of the barrier seal feedthrough.

4.11.2 Test and Method IId barrier material.

(a) Mount the feedthrough in a piece of Method IId barrier material. Place the barrier material and feedthrough in a test jig so that the external part of the feedthrough is covered with water to a depth of 1/4 inch. Apply air pressure of 5 pounds per square inch to the internal side of the barrier. Examine the various parts of the barrier seal feedthrough for the presence of recurring air bubbles.

(b) Repeat the test of 4.11.2a by inverting the barrier and barrier seal connector in the test jig by applying the pressure to the external side of the feedthrough.

4.12 Nonreading tests.

4.12.1 Temperature humidity test (nonreading): The meter (corrosion meter or visual alarm), the cord, and the barrier seal feedthrough shall be subjected to 10 cycles as specified in MIL-STD-202, Method 106. After this test each component shall meet the requirements of applicable paragraphs of this specification. The corrosion meter shall meet the requirements of 4.10.1.1 and 4.10.1.3 and the corrosion alarm shall meet the requirements of 4.10.2.1 and 4.10.2.3 after this test.

4.13 Hot storage test: The corrosion meter, cord, and the barrier seal feedthrough shall be sealed in a six gallon reusable container, per Specification MIL-C-6054 and Drawing AN-8025, with 2 units of desiccant. The container shall be subjected to a temperature of +70°C for 48 hours and then to room temperature for 48 hours. The meter shall meet the requirements of 4.10.1.1 or 4.10.2.1, whichever is applicable; the barrier seal feedthrough shall meet the requirements of 4.11 and the cord shall meet the requirements of 4.7c.

4.14 Cold storage test: The corrosion meter, cord, and the barrier seal shall be sealed in a six gallon reusable container, per Specification MIL-C-6054 and Drawing AN-8025, with 2 units of desiccant. The container shall be subjected to a temperature of -60°C for 48 hours and then to room temperature for 48 hours. The indicator shall meet the requirements of paragraph 4.10.1.1 or 4.10.2.1, whichever is applicable; the barrier seal feedthrough shall meet the requirements of paragraph 4.11, and the cord shall meet the requirements of paragraph 4.7c and 4.18.

4.15 Vibration test.

4.15.1 A corrosion sensing element and barrier seal feedthrough shall be mounted in a Method IIa simulated package constructed as follows:

(a) The base shall be constructed of fir plywood as shown in Figure 2-40 of TM 38-230, 1957 edition. Over-all dimensions of the base shall be 24 inches x 24 inches x 1-1/2 inches.

(b) Barrier material shall be attached as shown in Figures 2-41 and 2-42 of TM 38-230.

(c) The packaged "equipment" shall be simulated by a box made of 3/4 inch fir plywood and shall have external dimensions of 12 x 12 x 12 inches.

Two centrally located holes, six inches in diameter shall be cut in opposite sides of the box. The box shall be bolted to the base as shown in Figure 2 43 of TM 38-230, so that the two six-inch holes are at right angles to the base.

(d) The box shall be cushioned with creped cellulose wadding as shown in Figure 2-44 of TM 38-230 without obstructing the holes in the box.

(e) The corrosion sensing element and barrier seal feedthrough shall be installed in the barrier material so that they will be approximately centered at one of the six-inch holes.

(f) The barrier shall be closed as shown in Figures 2-46, 2-48, and 2-49 of TM 38-230. The barrier shall be cut away at the six-inch hole opposite the element.

(g) The package shall be completed as shown in Figure 2-51 of TM 38-230 so that over-all dimensions are approximately 24 x 24 x 18 inches, except that one board shall be left off each side to permit free view of the installed element and connector.

(h) The package shall be fastened on a vibration table that can be controlled within 10 percent of the specified amplitude and can provide approximately sinusoidal vibration.

(i) The package shall be vibrated successively in three mutually perpendicular directions that are parallel respectively to the edges of the equipment, over a frequency range of 10 to 55 cycles per second in 1-cycle-per second steps. The total excursion shall be constant at 1/64 inch.

(j) Mechanical resonance, if any, of the equipment will be determined visually by means of a Strobotac, as made by the General Radio Corporation, Cambridge, Massachusetts, or equal.

4.15.2 The corrosion sensing element, and barrier seal feedthrough, shall be mounted in a Method IId simulated package constructed as follows:

(a) The container shall be a six gallon reusable container per Specification MIL-C-6054 and Drawing AN-8025 with a six inch diameter hole cut from the bottom.

(b) The inside wall of the container shall be lined from top to bottom with a two-inch layer of wood (fir) so that the wood will remain in place throughout the test.

(c) The element and feedthrough shall be mounted in the lid of the container, so that they cannot contact the wood inside the container during the test, and the lid shall be mounted on the container.

(d) The package shall be fastened on a vibration table that can be controlled within 10 percent of the specified amplitude and can provide approximately sinusoidal vibration.

(e) The package shall be vibrated successively in three mutually perpendicular directions that are parallel respectively to the edges of the equipment, over a frequency range of 10 to 55 cycles per second in 1-cycle-per-second steps. The total excursion shall be constant at 1/64 inch.

(f) Mechanical resonance, if any, of the equipment will be determined visually by means of a Strobotac, as made by the General Radio Corporation, Cambridge, Massachusetts, or equal.

4.16 Bounce test: The corrosion sensing element and barrier seal feedthrough shall be mounted in a Method IIa simulated package constructed as described in 4.15.1a through 4.15.1g and shall be placed on the table of the Package Tester as made by the L.A.B. Corporation, Summit, N.J., or equal, and shall be constrained from horizontal motion of more than two inches by suitable wooden fences. The package tester, shafts in phase, shall be operated at a speed of 285 rpm $\pm$ 1 percent for a total of three hours. During each 1/2 hour period of the test, the case shall rest on a different face.

4.17 Inspection for Interchangeability: The dimensions listed below shall be gaged or measured to determine compliance with the physical interchangeability requirement of paragraph 3.10. When a listed dimension is not within specified or design limits, it shall be considered a major defect.

(a) External and internal dimensions of cases, covers, and insertable subassemblies, when such dimensions affect mating of parts.

(b) Internal dimensions of cavities in cases and assemblies, when such dimensions affect acceptability of insertable subassemblies.

(c) Location of hinges and fasteners on separable parts or assemblies which must mate together, such as cases, covers, and mounting.

(d) Location and size of connectors, locking pins, fasteners, slides, and mountings which receive mating parts of plug-in assemblies and major components.

(e) Location and size of connectors, locking pins, fasteners, slides, and mountings on plug-in assemblies.

(f) Size and form of special threads.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging.

5.1.1 Level A. The corrosion sensing elements shall be packaged by themselves in metal cans conforming to Specification PPP-C-96, type V, Class 2. At the bottom of the can shall be placed a bag (or group of bags) of desiccant conforming to Specification MIL-D-3464, Class 2. The elements will then be placed in the container and on top of them shall be placed another bag (or group of bags) of desiccant. On top of this bag (or layer of bags) shall be placed a matchbook type visual corrosion indicator, Specification MIL-I- , Class 2, which is approximately twice as sensitive to corrosion as the packaged indicators. This special matchbook type indicator will be permanently attached to a card on which shall be printed the following:

NOTICE. The contents of this container are especially sensitive to moisture and may be permanently damaged by an exposure to the normal atmosphere lasting longer than a few minutes. Attached to this card is a doubly sensitive indicator which will indicate the condition of the contents of this container. If this special indicator should be brown in color over any portion of its metal film coated surface, it shows evidence of a corrosive environment and the contents of this container have been damaged. Close the container tightly and return to the issuing agent.

DO NOT ALLOW ANY CONTACT WITH MOISTURE.

Other assemblies shall be preserved and packaged individually, or as otherwise specified

in accordance with Method 1C of Specification MIL-P-116.

5.1.2 Level B: The corrosion sensing elements shall be packaged individually in clear, heat sealable, plastic bags. Each bag shall contain one corrosion sensing element and sufficient desiccant to maintain a relative humidity within the plastic bag of less than 40% under all foreseeable conditions. The desiccant used will be silica gel powder of a size which will pass through a standard 100 mesh screen. The individually packaged corrosion sensing elements shall then be packaged in cans conforming to type V, class 2, Plan B coating of Specification PPP-C-96. Unless otherwise specified, the number of individually packaged corrosion sensing elements per container will be either 25 or 100. The individually packaged corrosion sensing elements shall be packaged as follows: A bag, or bags, of desiccant, MIL-D-3464, class 2, shall be placed at the bottom of the container. The desiccant used shall be silica gel unless otherwise authorized. The individually packaged corrosion sensing elements shall then be placed in the container and another bag, or bags, of desiccant placed on top of the corrosion sensing elements. The amount of desiccant used shall be as specified in Specification MIL-P-116, section 3.5.6: On top of this bag, or groups of bags, shall be placed a single Class 1, Matchbook type indicator, MIL- , not packaged in a plastic bag. This indicator shall be permanently attached to a card on which shall be printed the following:

NOTICE: The contents of this container are especially sensitive to moisture. Even though the individual indicators are packaged in plastic bags, excessive exposure to the atmosphere may cause permanent damage, since the plastic is not completely impervious to moisture. Attached to this card is a standard indicator which will indicate the extent of possible damage to the exposed contents. If this indicator shows evidence of having been exposed to a corrosive environment, the contents of this container may have been damaged. Close the container tightly and return to the issuing agent.

DO NOT ALLOW ANY CONTACT WITH MOISTURE.

5.1.2.1 Handling instructions: In addition to the information specified in the preceding paragraphs, the notice given below shall be placed in a conspicuous position on the out-

side of each corrosion sensing element container. It shall be durably and legibly printed and placed on the container in such a manner that the marking will not be damaged when the container is opened.

CAUTION: The contents of this container will be spoiled if they become damp. The contents will be permanently damaged if exposed to the normal atmosphere for more than a few minutes. This container positively must not remain open for any longer period than is absolutely necessary for withdrawals. Withdrawals should be as near as possible to the exact quantity intended to be used. The container shall be tightly resealed immediately after any withdrawal.

5.1.3 Level C: Corrosion Sensing Element, Resistance; Meter, Corrosion Electrical Resistance; Barrier Seal Connector; and Cord, Connecting, shall be packaged in accordance with good commercial practice and in a manner that will afford protection against corrosion, deterioration and physical damage during direct shipment to the first receiving activity.

5.2 Packing.

5.2.1 Level A: Meters, corrosion sensing elements, barrier seal feedthroughs, and cords, packed as specified (See 6.1) shall be packed in wood cleated fiberboard overseas type, nailed wood (Class 2) corrugated solid fiber, wood cleated paper overlaid veneer (Overseas type) wirebound wood (for Class C use) or wood cleated plywood (Overseas type) boxes conforming to Specifications PPP-B-591, PPP-B-621, JAN-P-108, MIL-B-10377, PPP-B-585, and PPP-B-601, respectively. Shipping containers shall have case liners conforming to Specification MIL-L-10547 and appendix thereto. Box closures shall be as specified in the applicable box specification or appendix. The gross weight of wood boxes shall not exceed 200 pounds: Fiberboard boxes shall not exceed the weight limitation of the reference box specification.

5.2.2 Level B: Meters, corrosion sensing elements, barrier seal feedthroughs, and cords, packed as specified (See 6.1) shall be packed in wood cleated fiberboard (Domestic type) nailed wood (Class 1) corrugated or solid fiberboard, wirebound (for Class 1 use) and wood cleated plywood (Domestic Type) or wood cleated paper overlaid veneer (Domestic type) boxes conforming to Specification PPP-B-591, PPP-B-621, LLL-B-636, PPP-B-585,

PPP-B-601, and MIL-B-10377 respectively.

5.2.3 Level C: Corrosion Sensing Element, Resistance; Meter, Corrosion, Electrical Resistance; Barrier Seal Feedthrough; and Cord, Connecting, shall be packed for shipment in a manner conforming to the requirements for Uniform Freight Classification for rail shipment, National Motor Freight Classification for truck shipment, Parcel Post Regulations, and the regulations of other carriers as applicable to the mode of transportation employed at lowest transportation rate.

5.3 Marking for shipment: Interior packages and exterior shipping containers shall be marked in accordance with applicable provisions of Standard MIL-STD-129.

6. NOTES

6.1 Intended use: The corrosion indicating systems covered by this specification are for use in monitoring the corrosiveness of the atmosphere within a sealed package or container, at any time, without opening it. The system will indicate a potentially dangerous corrosive condition due to a high relative humidity or to the presence of a corrosive gas or chemical. The corrosion indicating systems may also be used to monitor the atmosphere in any storage chamber, room, or warehouse. Corrosion sensing elements may be placed at different points on the walls, or at different points in the interior of a chamber to indicate the presence of any localized potentially corrosive environment. The indicators may be used in accordance with a schedule, or continuously. The indicators (corrosion meters or visual alarms) may be carried by hand, or may be permanently located at some point a considerable distance away from the corrosion sensing elements. The indicators will record the total amount of corrosiveness to which the equipment has been subjected since the package was sealed. The systems are effective in measuring the presence of ozone, acid vapors, salts, etc., in addition to denoting the presence of a potentially corrosive moisture level. The corrosion sensing elements respond much more rapidly to corrosive conditions than do stored parts, and thus indicate potentially corrosive conditions well in advance of the time that any corrosion will have occurred on hardware. This permits corrective measures to be taken in advance of any actual damage due to corrosion.

6.2 Ordering data: Procurement documents should specify the following:

(a) Title, number, and date of this specification and any amendments thereto.

(b) Length and quantity of cords. (See 3.6.4).

(c) Place of final inspection.

(d) Type of assembly. (See 3.6.5).

(e) Quantities per package. (See 5.1.1).

6.3 Nomenclature: The parentheses in nomenclature will be deleted or replaced by a letter identifying the particular design. As soon as possible after the award of the contract, the contractor should apply to the Government office specified in the contract for such information. (See 1.1).

6.4 Group C inspection: Approval to ship may be withheld, at the discretion of the Government inspector, pending the decision from the Contracting Officer on the adequacy of corrective action.

6.5 Qualification: With respect to products requiring qualification, awards will be made only for such products as have, prior to the bid opening date, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date.

6.5.1 The attention of suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification in order that they may be eligible to be awarded contract or orders for the products covered by this specification. Information pertaining to qualification or products covered by this specification may be obtained from the Air Force Mobile.

NOTICE: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to

manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodians:

Army--Signal Corps

Navy--Bureau of Aeronautics

Air Force

Other interests:

Army--CMQT OE

Navy--McOrShSY

Preparing activity:

Army--Signal Corps

TABLE I. QUALIFICATION INSPECTION

Inspection	Req. Par.	Test Par.	No. of Samples	Allowable Defectives
Corrosion Sensing Elements				
Visual and mechanical	3.6.1	4.7a	50	2
Interchangeability	3.10	4.17	10	1
Vibration	3.7.2c	4.15	6	0
Bounce	3.7.2d	4.16	6	0
Electrical characteristics	3.6.1	4.8	10	1
Barrier Seal Feedthrough				
Visual and mechanical	3.6.3	4.7d	10	0
Interchangeability	3.10	4.17	10	0
Temperature-humidity	3.7.2	4.12.1	10	-
Hot storage	3.7.2	4.13	10	-
Cold storage	3.7.2	4.14	10	-
Vibration	3.7.2c	4.15	3	0
Bounce	3.7.2d	4.16	3	0
Leakage	3.6.3 thru 3.6.3.3	4.11	10	1
Cord				
Temperature-humidity	3.7.2	4.12.1	10	-
Hot storage	3.7.2	4.13	10	-
Cold storage	3.7.2	4.14	10	-
Visual and mechanical	3.6.4	4.7c	10	0
Interchangeability	3.10	4.17	10	0
Corrosion meter				
Visual and mechanical	3.13	4.7b	2	0
Interchangeability	3.10	4.17	2	0
Check circuit	3.6.2.1.1	4.10.1.1	2	0
Short circuit	3.6.2.1.2	4.10.1.3	2	0
Battery life	3.6.2.3.1	4.9.1	2	0

TABLE I. QUALIFICATION INSPECTION (Con't.)

Inspection	Req. Par.	Test Par.	No. of Samples	Allowable Defectives
Calibration at +25°C	3.6.2.1	4.10.1.1	2	0
Calibration at +5°C	3.6.2.1	4.10.1.2	2	0
Calibration at 40°C	3.6.2.1	4.10.1.2	2	0
Hot storage	3.7.2	4.13	2	0
Cold storage	3.7.2	4.14	2	0
Temperature-humidity	3.7.2	4.12.1	2	-
Corrosion alarm				
Visual and mechanical	3.13	4.7b	2	0
Interchangeability	3.10	4.17	2	0
Check circuit	3.6.2.2.1	4.10.2.1	2	0
Short circuit	3.6.2.2.2	4.10.2.3	2	0
Battery life	3.6.2.3.2	4.9.2	2	0
Calibration at +25°C	3.6.2.1	4.10.2.1	2	0
Calibration at +5°C	3.6.2.1	4.10.2.2	2	0
Calibration at 40°C	3.6.2.1	4.10.2.2	2	0
Hot storage	3.7.2	4.13	2	0
Cold storage	3.7.2	4.14	2	0
Temperature-humidity	3.7.2	4.12.1	2	-

TABLE II. GROUP A INSPECTION

Inspection	Req. Par.	Test Par.	AQL*
Corrosion sensing element and barrier seal feedthrough			
Visual and mechanical, major	3.6.1 and 3.6.3	4.7	1.0%
Visual and mechanical, minor	3.6.1 and 3.6.3	4.7	4.0%
Corrosion meter indicator			
Visual and mechanical, major	3.6.2.1	4.7	1.5 dphu
Visual and mechanical, minor	3.6.2.1	4.7	6.5 dphu
+25°C calibration	3.6.2.1	4.10.1.1	1.5 dphu
Short circuit	3.6.2.1.2	4.10.1.3	1.5 dphu
Check circuit	3.6.2.1.1	4.10.1.1	1.5 dphu
Visual alarm indicator			
Visual and mechanical, major	3.6.2.2	4.7	1.5 dphu
Visual and mechanical, minor	3.6.2.2	4.7	6.5 dphu
+25°C calibration	3.6.2.2	4.10.2.1	1.5 dphu
Short circuit	3.6.2.2.2	4.10.2.3	1.5 dphu
Check circuit	3.6.2.2.1	4.10.2.1	1.5 dphu
Cord			
Visual and mechanical, major	3.6.4	4.7	1.0%
Visual and mechanical, minor	3.6.4	4.7	4.0%

* AQL - Acceptable Quality Level, allowable percentage of defective units.
dphu - defects per hundred units. For further information refer to MIL-STD-105.

TABLE III. GROUP B INSPECTION

Inspection	Req. Par.	Test Par.	AQL
Corrosion sensing element			
Electrical characteristics	3.6.1	4.8	3.0
Barrier seal feedthrough			
Hot storage	3.7.2	4.13	2.5
Cold storage	3.7.2	4.14	2.5
Leakage	3.6.3 - 3.6.3.3	4.11	1.0 (See Note 1)
Corrosion meter indicator			
Temperature-humidity	3.7.2	4.12.1	2.5
Hot storage	3.7.2	4.13	2.5
Cold storage	3.7.2	4.14	2.5
Visual alarm indicator			
Temperature-humidity	3.7.2	4.12.1	2.5
Hot storage	3.7.2	4.12.1	2.5
Cold storage	3.7.2	4.14	2.5

Note 1. Tests on the barrier seal feedthrough shall be conducted in the order indicated. The combined groups of feedthroughs tested in 4.13 and 4.14 shall be used in the test of 4.11.

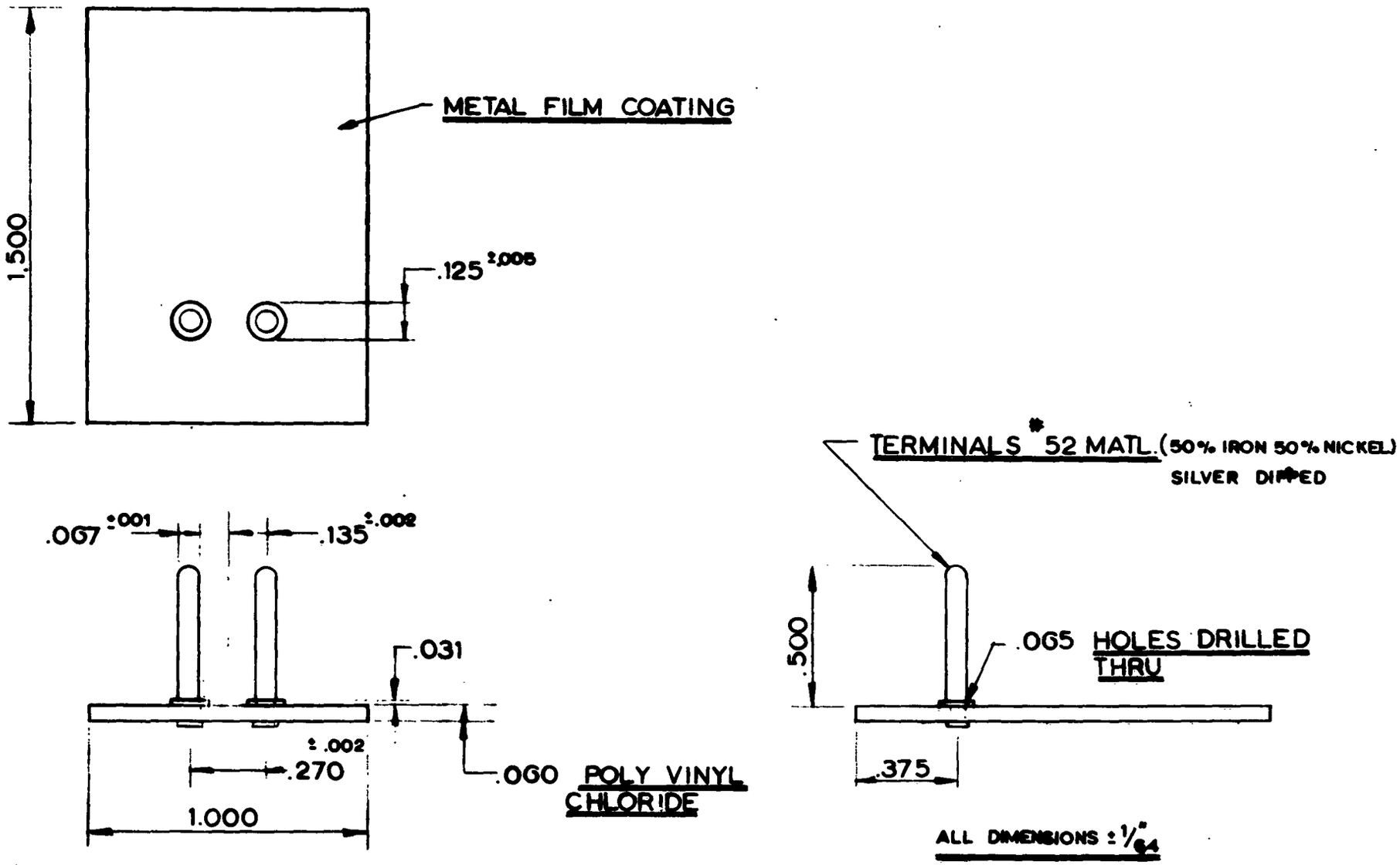


FIGURE 1

CORROSION SENSING ELEMENT

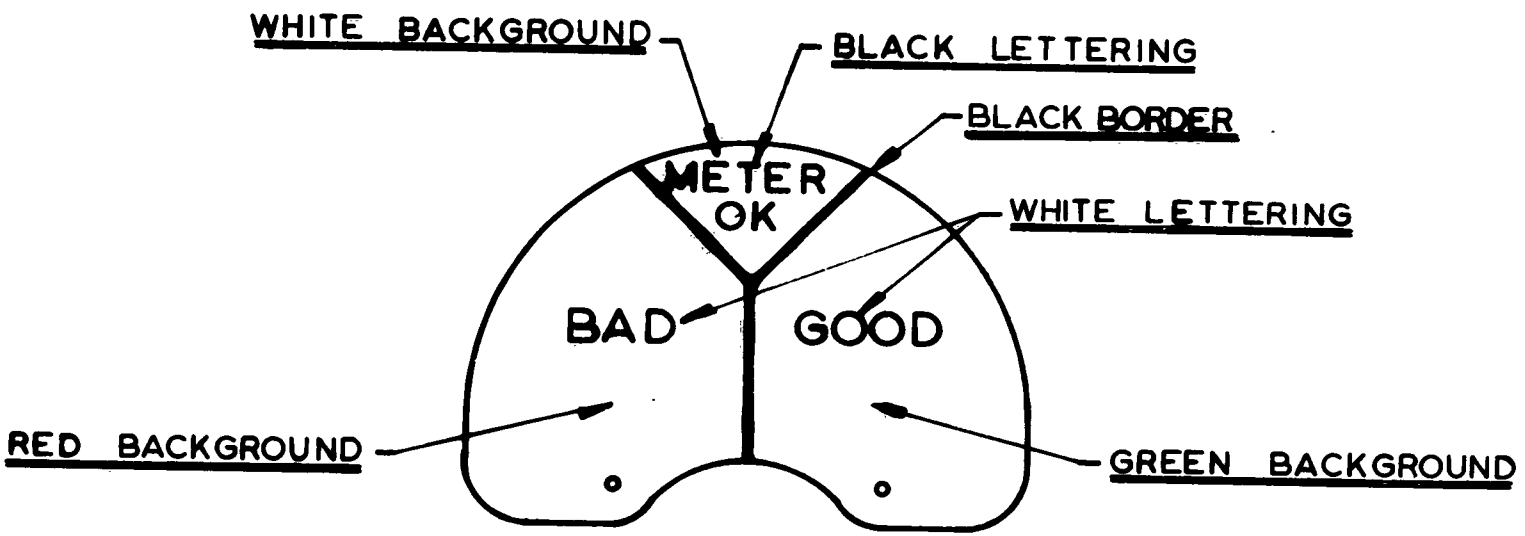
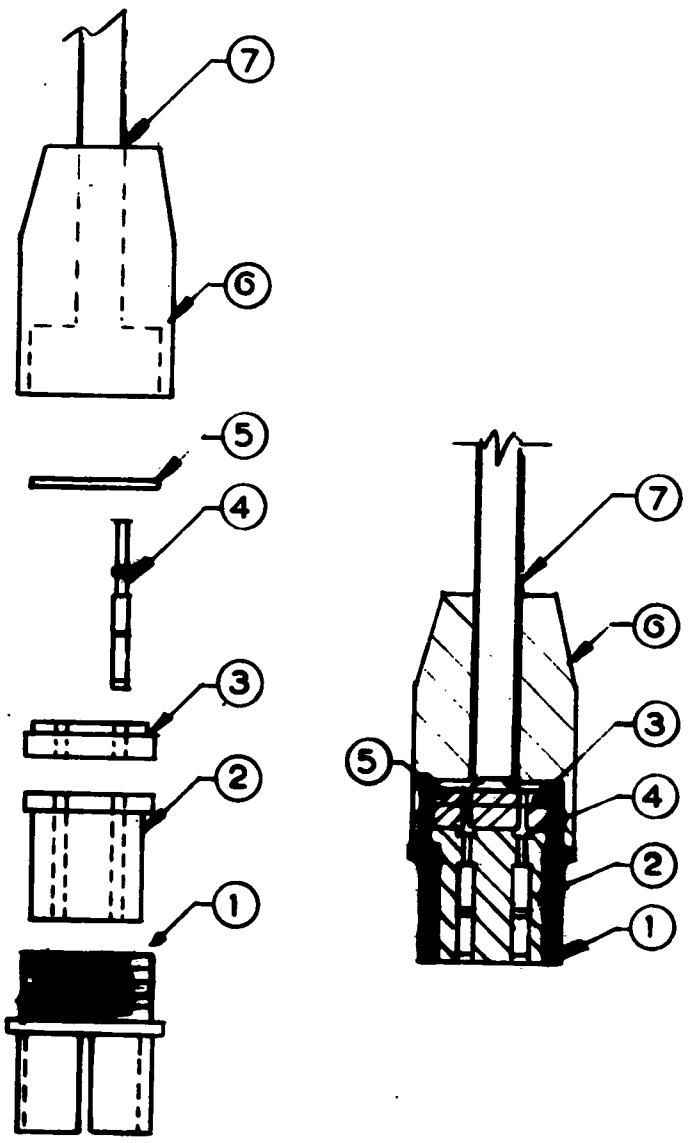


FIGURE 2
CORROSION METER DIAL



ITEM 5 EPD FLEXIBLE EPOXY RESIN TC-459 (black) AND USE CONNECTOR POTTING FORM PF-14

ITEM	DESCRIPTION	REQD.
7	CABLE (BELDEN 8414)	26"
6	POTTED HANDLE	1
5	RETAINER RING	1
4	PIN CONTACTS	2
3	BACK INSERT	1
2	FRONT INSERT	1
1	SHELL	1

FIGURE 3

FEMALE ELECTRICAL TERMINAL

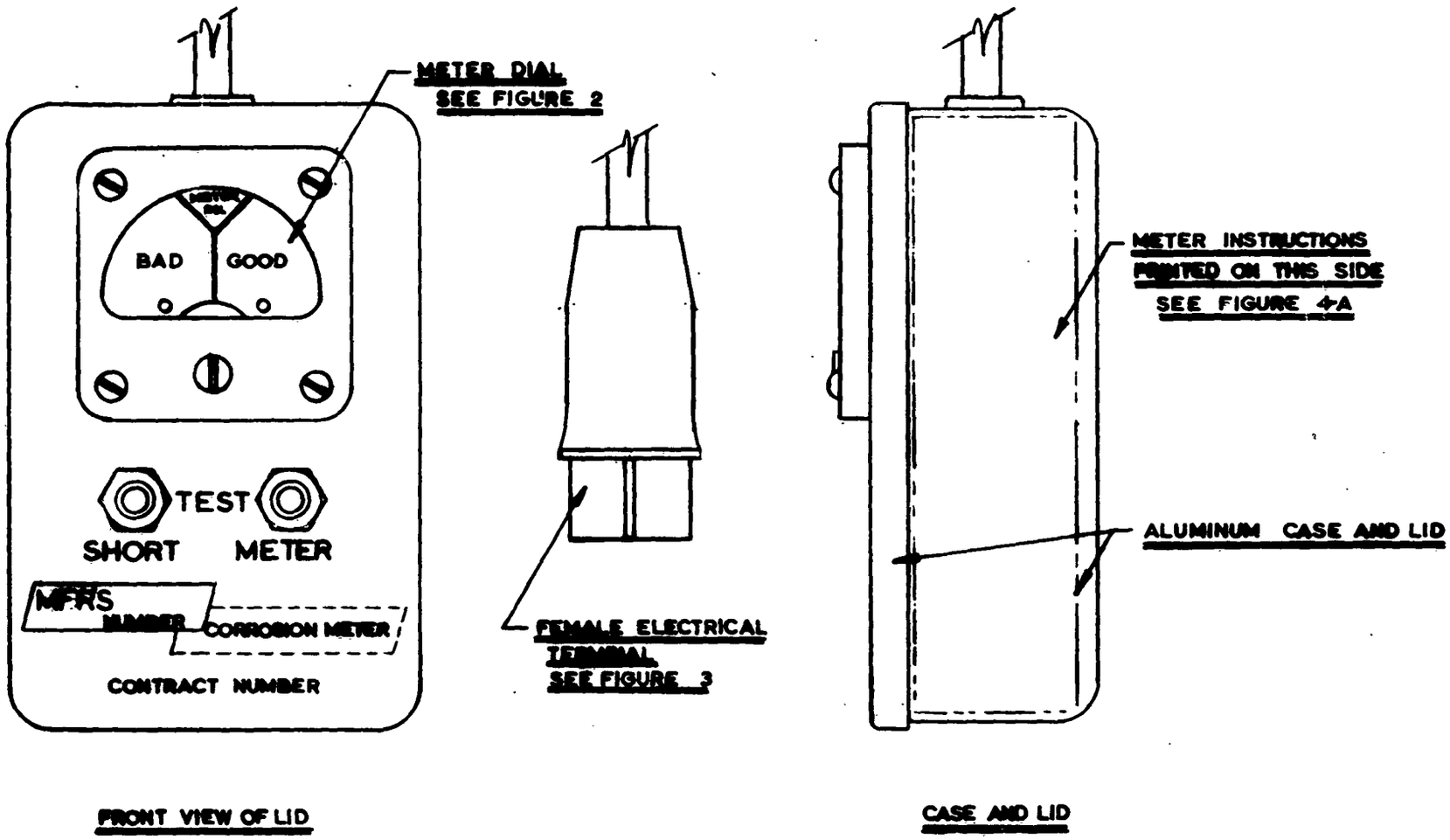


FIGURE 4
CORROSION METER CASE

INSTRUCTIONS

1. CONNECT METER TO CORROSION INDICATOR WITH ATTACHED PLUG.
2. METER WILL AUTOMATICALLY INDICATE EITHER "GOOD OR BAD".
3. "BAD" READING DENOTES A CORRODED INDICATOR. ALWAYS INSTALL A NEW INDICATOR.

METER CHECK PROCEDURE

1. FIRMLY DEPRESS "METER CHECK" BUTTON MOMENTARILY. IF METER NEEDLE DOES NOT READ METER OK, REPLACE BATTERIES.
2. FIRMLY DEPRESS "SHORT CIRCUIT TEST" BUTTON MOMENTARILY. IF METER NEEDLE READS "BAD", THERE IS A SHORT CIRCUIT IN THE EXTERNAL CIRCUIT.

FOR FURTHER INFORMATION REFER TO TECHNICAL MANUAL NO._____, PARAGRAPHS _____.

MANUFACTURER'S NO._____.

FIGURE 4-A
INSTRUCTIONS FOR CORROSION METER

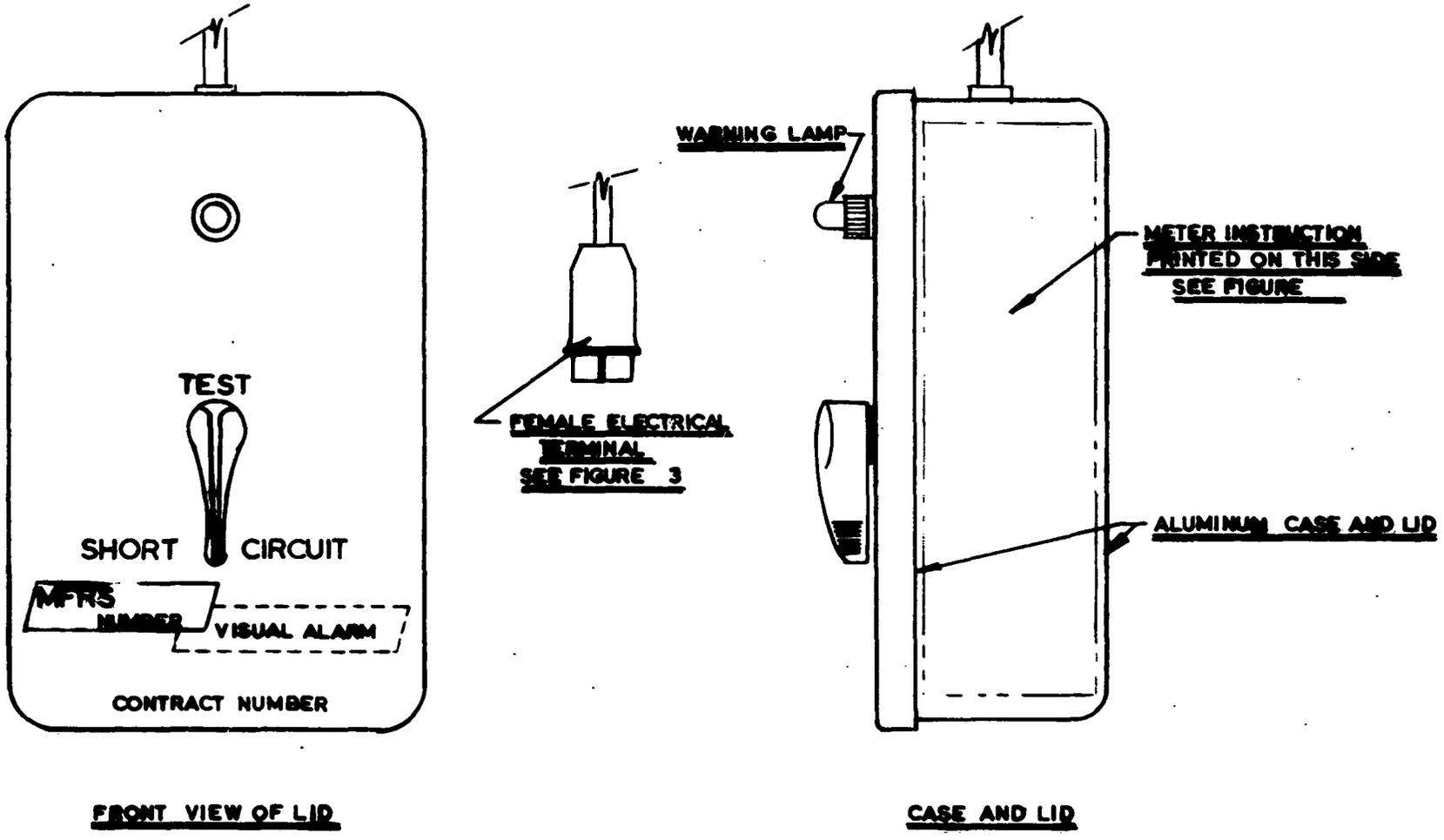


FIGURE 5
VISUAL ALARM

INSTRUCTIONS

1. CONNECT VISUAL ALARM TO CORROSION INDICATOR WITH ATTACHED PLUG.

2. VISUAL ALARM WILL INDICATE A CORROSIVE CONDITION IF THE LIGHT FLASHES.

3. ALWAYS INSTALL A NEW SENSING ELEMENT WHEN RE-PACKING.

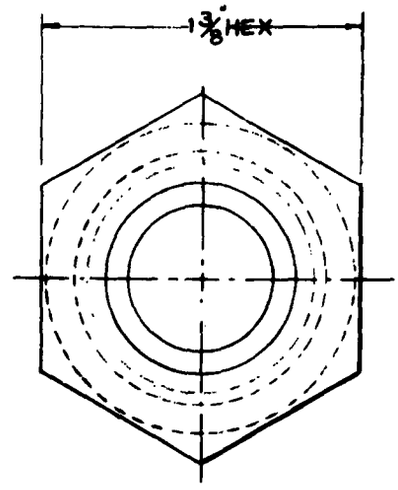
VISUAL ALARM CHECK PROCEDURE

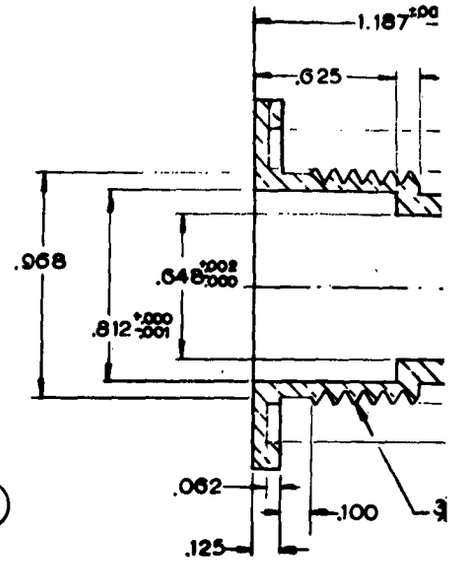
1. TURN THE SELECTOR SWITCH TO THE "CIRCUIT TEST" POSITION AND HOLD IT THERE. IF LIGHT DOES NOT FLASH, REPLACE BATTERIES.

2. TURN THE SELECTOR SWITCH TO THE "SHORT TEST" POSITION AND HOLD IT THERE. IF THE LIGHT FLASHES, THERE IS A SHORT IN THE EXTERNAL CIRCUIT.

FIGURE 5-A

INSTRUCTIONS FOR VISUAL CORROSION ALARM





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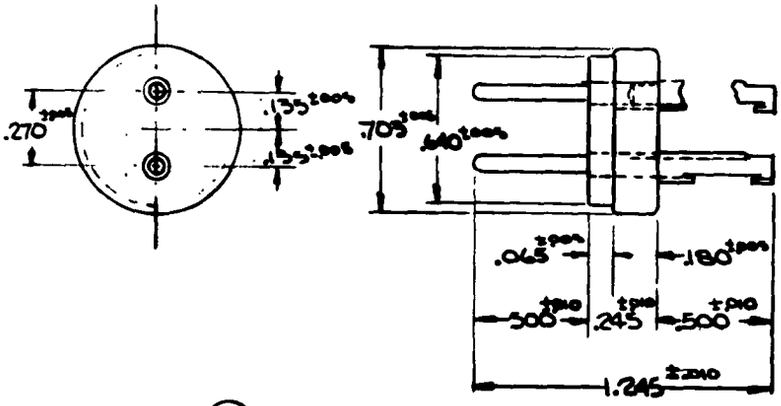

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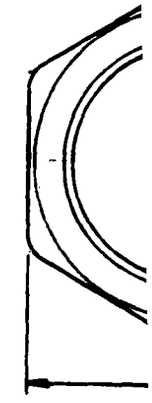

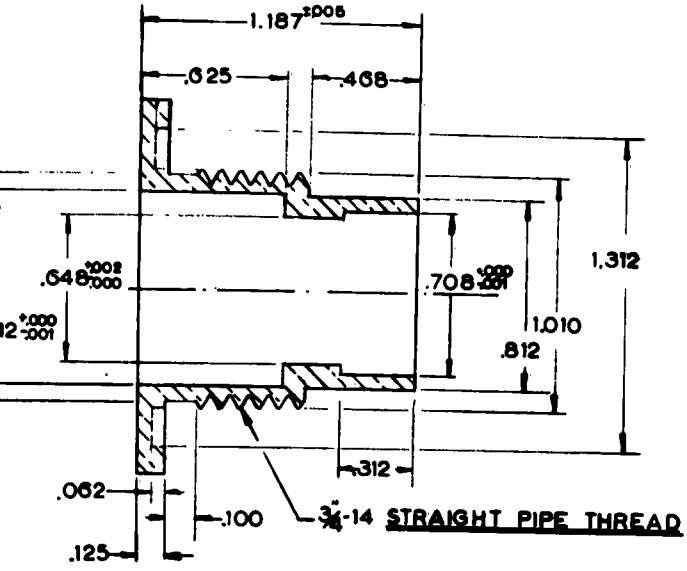

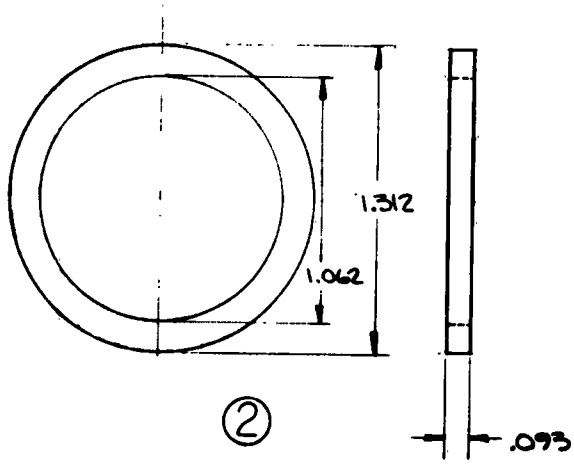

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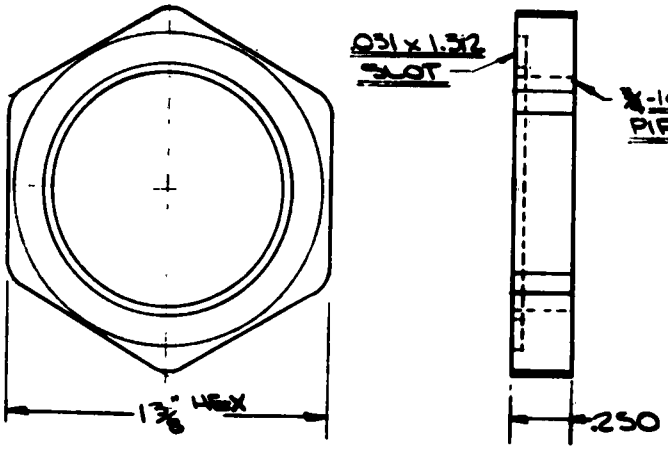

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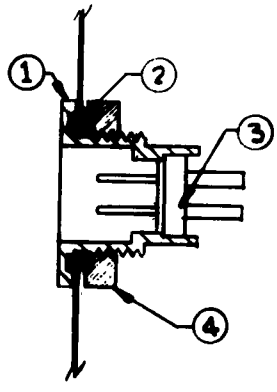
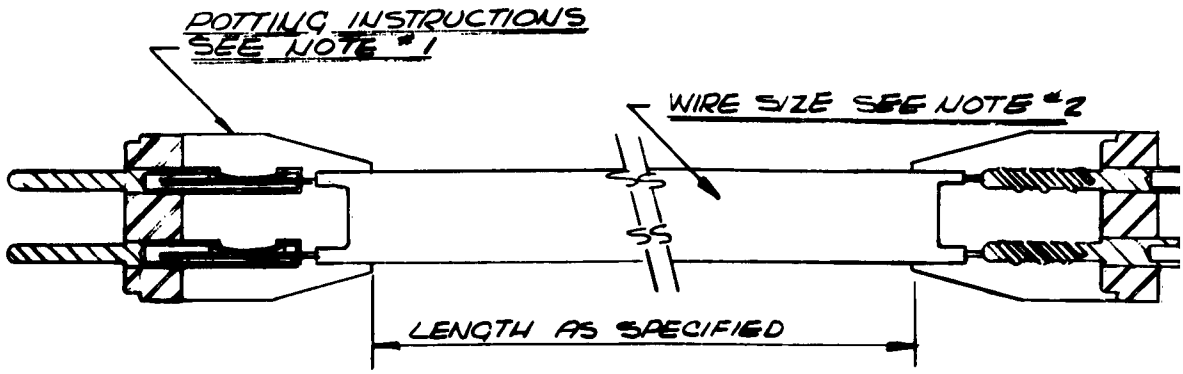
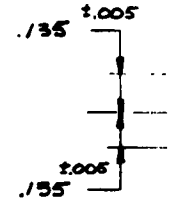


4	LOCK NUT	AL
3	CONTACT SOCKET	
2	GASKET	RUBBER
1	BODY	AL

FIGURE 6
BARRIER SEAL FEEDTHROUGH



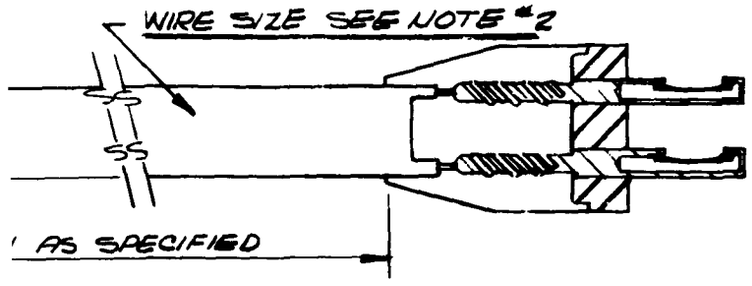


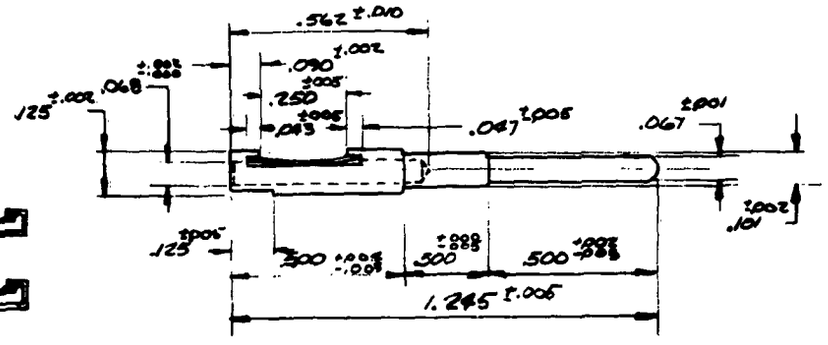
4. HOUSING: DIALLYL PHTHALATE ES-5
3. PINS: BERYLLIUM COPPER - SILVER TINNED.
2. WIRE SIZE IS DEPENDENT UPON THE LENGTH OF THE EXTENSION CABLE. LENGTHS LESS THAN 200 FEET USE NUMBER 18 WIRE, BETWEEN 200 AND 300 FEET USE NUMBER 16 WIRE, BETWEEN 300 AND 500 FEET USE NUMBER 14 WIRE.
1. USE G.P.D. FLEXIBLE EPOXY RESIN TC-459 (BLACK) AND USE CONNECTOR POTTING FORM DF-14

NOTES:

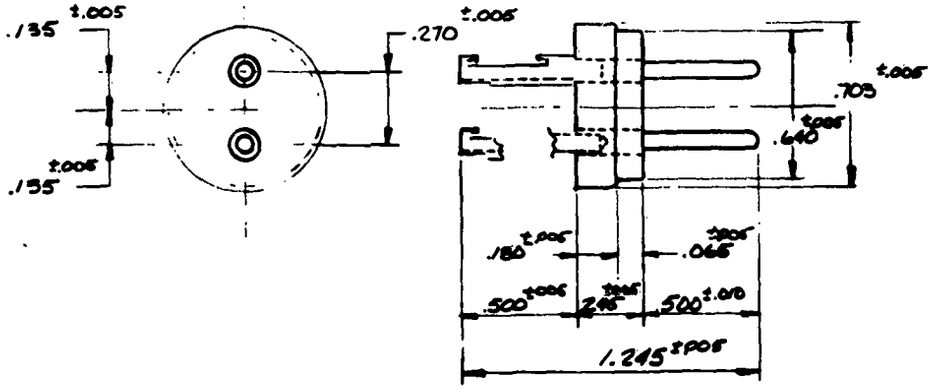
FIGURE 7
EXTENSION CORD

DNS





PIN DETAIL
SCALE 5 X SIZE



ES-5
IER TINNED.
THE LENGTH OF
S LESS THAN 200
TWEEN 200 AND
E. BETWEEN
14 WIRE

SIN TC-659
ING FORM DF-14

FIGURE 7
EXTENSION CORD

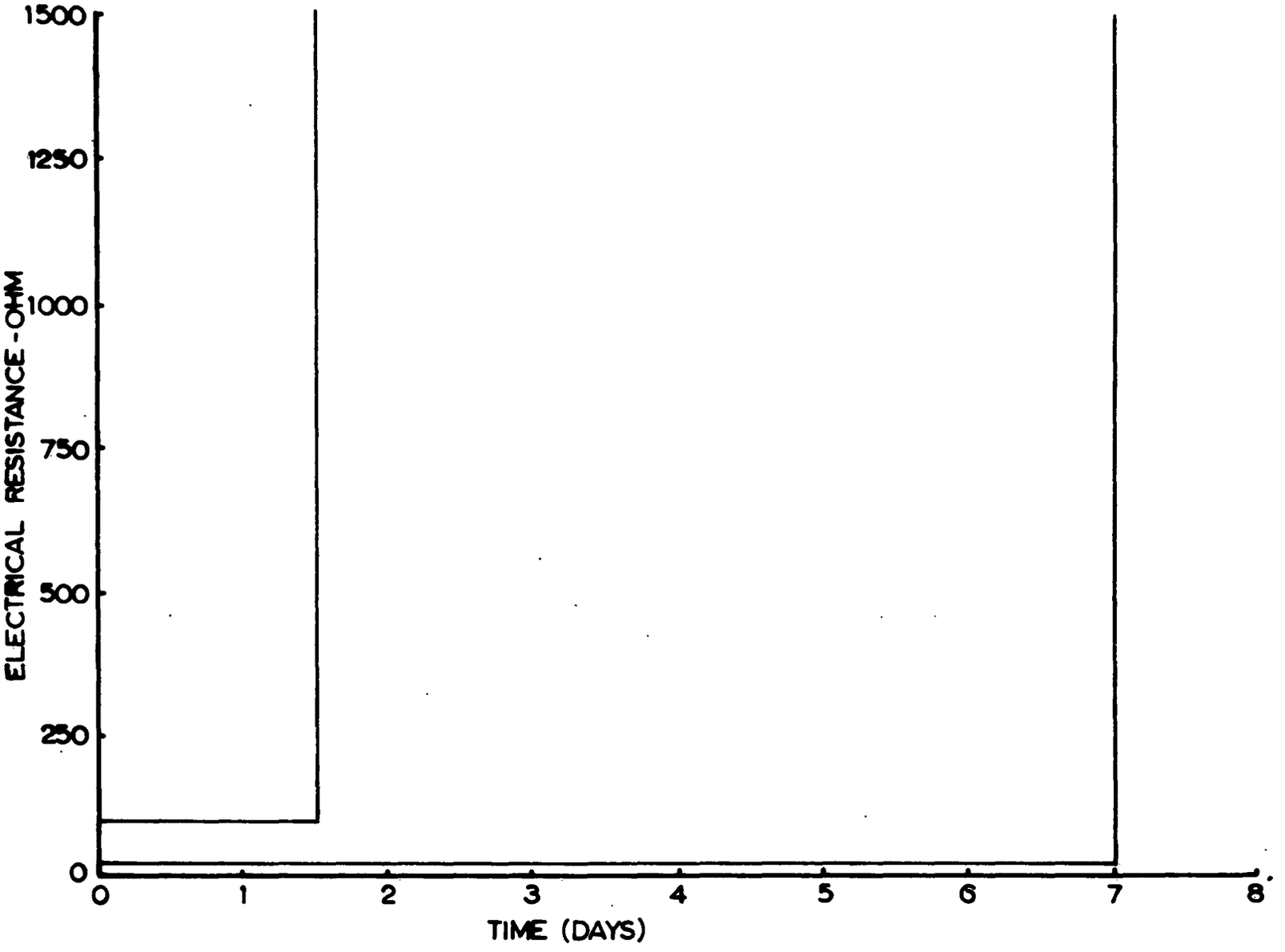


FIGURE 8

RESISTANCE VS TIME CURVE

2. Corrosion: Causes, effects, and methods of prevention.

2.1 Introduction. It has been conservatively estimated that the costs of combatting corrosion through coatings, treatments, and discarded equipment exceed two billion dollars per year in the United States. This figure covers only the direct costs of money actually expended in the fight against corrosion. The indirect costs resulting from equipment malfunction due to corrosion -- the loss of production due to down-time, loss of time while key parts are replaced or redesigned, and actual loss of life due to failure of key components -- are incalculable but undoubtedly exceed the direct costs many times. It is the indirect consequences which are of paramount importance in military use since many times the corroded articles may be irreplaceable at the time required due to the distance or inaccessibility of the source of supply. Corrosion may be general in nature such as the rusting of an iron surface, or it may be confined to a very small surface area as in the case of intergranular corrosion. It may appear on the surface as pitting, or it may take place beneath the head of a rivet or on the inside of a joint. It may result in a physical reduction in size or in an internal weakening of the metal being corroded. The results of the corrosion may be apparent to the naked eye or they may be detected only when the part malfunctions or physically fails in service.

2.2 Malfunction of equipment due to corrosion during storage.

2.2.1 Mechanical equipment. Uncontrolled corrosion can result in the complete disintegration of a metal part or machine. This is the extreme, however. The great majority of damage resulting from corrosion is experienced before this stage is reached. Even mild corrosion can result in malfunction and sometimes even mechanical failure of a part. Minute amounts of corrosion of the intergranular type can result in stress corrosion and fatigue failure of highly stressed parts. Galvanic cells or crevice corrosion cells may result in the weakening of brazed joints, rivets, or bolts which may later fail in service. The products of corrosion, minute though they may be, are particularly dangerous when they are produced in, or find their way into, close clearance assemblies. In such instances they may cause galling or seizure of mating parts. Corrosion products, even those only a few microns in size, can be dangerous in any hydraulic system. As the trend today is toward ever higher performance systems, higher pressures, closer clearances, and higher stresses are being used. Systems are thus becoming more and more vulnerable to corrosion, as even

small amounts can result in excessive fatigue stresses and contamination of high pressure hydraulic or pneumatic systems. For these reasons it should be apparent why even a minute amount of corrosion during storage, often so small an amount as to be visually undetectable, should be prevented if at all possible.

2.2.2 Electrical equipment. Electrical and electronic gear are also quite vulnerable to corrosion. Even as the trend is toward higher performance mechanical systems, so also is it toward higher performance electrical systems. This means more heavily loaded circuits, more sensitive components, faster response times, and a requirement for increased reliability. Even with the increased use of solid state materials, electronic welding of connections, and potting of assemblies and subassemblies, other factors remain such that corrosion of electronic gear, even in minute amounts, will be a very serious problem throughout the foreseeable future. Switching contacts are particularly vulnerable, as even mild tarnishing of silver contacts increases their resistance and reduces the probability of satisfactory operation while simultaneously lowering their current carrying capacity. Meter movements and potentiometer contacts are also particularly susceptible to corrosion as are unbonded strain gage elements frequently used in accelerometers and other types of electronic transducers. These, and many other electronic devices, are subject to malfunction as the result of only mild corrosion.

2.3 Mechanism of corrosion. Corrosion is generally considered to be the result of an electrochemical action leading to the conversion of a metal to a non-metallic corrosion product. An electrochemical corrosion cell may arise wherever two dissimilar, electrically conductive, electrically connected materials are connected by an electrolyte. The electrolyte may be any electrically conductive liquid, but is usually water containing dissolved substances. Pure water is essentially non-conductive and thus will not support corrosion in the pure state. Under the proper conditions, then, the dissimilar materials create a difference of electrical potential, and this potential difference is the driving force for the corrosion cell. Because all commercial grades of metal contain either alloying elements or slight impurities, it is theoretically possible to set up a galvanic corrosion cell on any metallic surface. Different metallurgical phases within the same metal may occupy different positions in the electromotive series, thus making possible galvanic cells. When metals are in contact with the atmosphere, another important source

of potential difference comes into play. This is the oxygen in the air. Oxygen is capable of converting an otherwise homogeneous metal surface into a patchwork of dissimilar areas, especially on steel and other ferrous alloys. In most cases this effect of oxygen is more powerful than the galvanic effect discussed above, and hence will determine the rate and distribution of corrosion. Many metals, including steels, form thin, invisible oxide layers on initial contact with air. If the environment is free from certain impurities, these oxide layers protect the underlying metal from rapid oxidation by slowing down the reaction. If impurities such as many kinds of salts, acids, and other chemicals together with water vapor are in contact with the metal, or are in the atmosphere so that they will contact the surface, the protective action of the oxide layer may be destroyed and oxidation continues unchecked. In summary, there are three basic requirements for corrosion to take place that are of interest in packaging and storage activities: (1) a metal, or combination of metals in contact with one another; (2) an electrolyte layer consisting of water and dissolved impurities; and (3) a source of potential difference between various locations on the metal surface. These and other factors contributing to corrosion are discussed further in the following sections.

2.4 Conditions conducive to corrosion.

2.4.1 Moisture and relative humidity. As discussed above, a potential electrolyte such as moisture must be present on the surface of the metal in order that corrosion may occur. Moisture is always present in the normal atmosphere in the form of water vapor. At any given moisture content in the air, a certain amount of water will be adsorbed onto metal surfaces. Under usual conditions the amount adsorbed is small and not enough to be visible. If the atmosphere is free from impurities, and the surface of the metal is scrupulously clean, the metal will be safe from corrosion under the protection of the oxide layer. At high temperatures and moisture contents (120°F and 90% RH) even this protection tends to break down.

Moisture content of the air is usually expressed as Relative Humidity (RH). As a result of extensive long-term testing, it has been found that oxidation (rusting) of mild steel is by far the most frequently observed type of corrosion, and that this type and most others can be effectively controlled if the RH is kept below 40%. This applies regardless of the nature of the impurities that may be present. This fact is the basis for much packaging and storage under dehumidified conditions.

2.4.2 Dust, dirt, and chemicals. Most forms of dirt and dust are sources of water-soluble salts, and thus promote corrosion of metals. Some types of dirt are hygroscopic and draw moisture out of the atmosphere even though the relative humidity of the environment may be quite low. In addition, heavy deposits of dirt or dust may shield affected areas from access to air and localllized differential aeration cells can result. Certain chemicals such as acids and strong oxidizing agents act to increase the rate of corrosion of metals over that observed in their absence. Moisture is still required for corrosion to occur, but the amount of moisture required will be less for some metals.

2.4.3 Fingerprints. Fingerprints on a metal surface are a prime source of potential corrosion. Whenever a clean surface is touched there is deposited a thin film of moisture, oils, and salts from the skin. This deposit is usually slightly acidic. This is an ideal condition for corrosion. Many parts have corroded badly where fingerprints have been left on the surface while remaining free from corrosion on the rest of the surface.

2.4.4 Crevices and differential aeration cells. One of the most concentrated and damaging forms of corrosion is that which occurs in crevices and other locations of limited access to air. In such cases the metal in the crevice acts as the anode of the corrosion cell, whereas the surrounding metal, receiving an excess of oxygen, acts as the cathode and may show no corrosion at all. Crevices subject to such attack are formed in many ways: Where two pieces of metal form a close fit, in lap joints, under the heads of rivets and bolts, and under any non-metallic substance that may be in contact with the metal. Because it occurs in recesses, crevice corrosion is often overlooked during visual inspection, only to result in mechanical failure during use of the object at a later time. Ferrous metals are by far the most vulnerable to crevice corrosion. Again, a certain moisture content in the environment is necessary to support such action.

2.5 Detecting corrosion during storage. There is no standard of tolerable corrosion damage. Most parts can tolerate a fair amount of general corrosion, but many of these same parts would fail if subjected to a much smaller total amount of corrosion concentrated at a critical point. Corrosion tends to occur at random, and because only slight amounts may result in malfunction, the only safe criterion which can be applied is that there should be no corrosion at all. It is frequently next to impossible to detect small amounts of corrosion distributed at random over a structure. Internal corrosion within "black boxes" or mechanical assemblies cannot be

detected from the outside. Potentiometer contacts, meter movements, unbonded strain gages, etc., are also usually completely enclosed or shielded from view if for no other reason than for physical protection. All of these factors make detection of corrosion in many critical locations impracticable, if not impossible. Some means must therefore be provided which will anticipate and indicate the presence of corrosive conditions before corrosion of hardware has had time to occur. Corrective measures may then be taken before the equipment has actually been damaged.

2.6 Methods of preventing corrosion. The engineer or designer usually has a choice between building an item so it won't corrode, or is very resistant to corrosion in the service for which it is intended, or building it without making special allowance for corrosion-resistance. Many times, however, the service will be such, or the cost limitations are such, that adequate corrosion resistant materials cannot be used, or the service life will be short enough so that the use of special, expensive, hard to procure materials cannot be justified. Where special precautions are not or cannot be taken to prevent corrosion, there are two avenues open to the designer. He can design his object so that it is large enough to safely withstand the expected amount of corrosion, or he can provide protection for it throughout its expected life. Ordinarily, particularly in the case of high performance, light weight, high strength aircraft and missile parts, precautions must be taken to prevent corrosion. This is especially true during the storage period. Not only must the equipment be protected against corrosion, but there must be some indication or measure of the effectiveness of the protection throughout the duration of the storage period. Corrosion may be prevented either by coating the item with a protective surface coating, or by controlling the environment in which the item is located, or both.

2.6.1 Coatings. Coatings used to protect metal parts from corrosion during storage are of a number of different types and are produced in many different ways. Some protective films such as oxides, phosphates, and chromates, are produced on the surface of the metal by chemical action. Other films, usually thicker and more corrosion-resistant, are produced electrically. Plating metal parts with a different, more corrosion-resistant metal, either by hot dipping or by electroplating is another method used to produce protective coatings. Cladding of rolled metal sheet is still another widely used method for some metals. Painting, coating with oil or grease, and coating with a removable plastic film are still other methods. All of these,

except the last two, are semi-permanent coatings employed to protect a part in service. Each type has its sphere of usefulness and each has its limitations. No coating can provide absolute protection against all types of corrosion, and most coatings will deteriorate somewhat if exposed to weathering. No matter what type of coating is used to protect a metal part, the part may be further protected if it is to be subjected to any extensive period of storage This is particularly true of assemblies, many of which contain components that, because of functional requirements, cannot be given protective coatings.

3. Requirements for a Corrosion Indicator.

3.1 Sensitivity and response time. It is apparent from the foregoing discussion that positive protection from corrosion during storage is essential, yet is a complex problem. Protective measures are subject to failure when least expected. This situation points up the need for the type of corrosion indicator which is the subject of this manual. Such an indicator shows when the environment of a package has become corrosive, and does so well in advance of the time that hardware would experience any appreciable corrosion damage. Corrosion damage does not take place instantaneously when the environment becomes corrosive. Time is required, and the extent of damage is the time integral of the corrosion rate under all conditions. The indicators described herein will signal within a small fraction of the time required for the same environment to affect normal steel surfaces.

3.2 Similarity to hardware in general corrosivity response. The indicator must corrode under the same conditions that hardware will corrode under (except for the time factor), and shall not corrode under conditions wherein hardware will not corrode. The subject indicators have these characteristics. Particularly important is the fact that these indicators show the same response to Relative Humidity as does bulk hardware, namely, that they corrode above 40% RH and do not corrode below this value.

3.3 Irreversibility. It is possible for the atmosphere in a package to become alternately corrosive and non-corrosive as the temperature changes. Lower night temperatures could produce a higher RH than in the daytime. Hence corrosion would occur at night, and eventually damage would accumulate. Humidity indicators show only the momentary level of Relative Humidity. In the situation above, they would show always a safe condition when inspected during the day, leading to a false conclusion regarding the protection obtained. The corrosion indicators of the metal film type are not reversible in this sense. If any

corrosion occurs on the element, the effect is permanent, regardless of the time sequence of corrosive conditions.

3.4 Handling precautions, general. To be able to provide adequate forewarning of potentially corrosive conditions, these corrosion sensing elements must be very sensitive, and must sense all corrosive conditions to which they are subjected. They cannot discriminate between a corrosive condition before they are placed in use and a corrosive condition after they have been placed in use. In addition, there must be a certain built-in delay period to protect the indicators during the package-pull-down period, during which period the relative humidity may be such that conditions are definitely corrosive. This pull-down period may last 24 hours or longer, depending upon the conditions prevailing at the time of packaging, the type of packaging, etc. The indicators must, therefore, have at least a 24 hour delay period built into them for them to perform satisfactorily under all types of packaging conditions. This built-in delay must protect the indicators from at least 24 hours of exposure to a corrosive relative humidity. If too much of the delay period is used up through exposure of the indicators to corrosive conditions before they are placed in a package, there will not be enough left to protect them during the package pull-down period, and the indicators will erroneously indicate a potentially corrosive condition.

SECTION II
OPERATION AND SERVICE INSTRUCTIONS

1. Indicator, Corrosion, "Matchbook", Metal Film, Visual, MIL-xxx.

1.1 Method of use. The matchbook corrosion indicator has been designed to detect and indicate a corrosive condition before any serious damage can occur to the packaged items. The indicator, as is shown in figure 1, consists of a piece of plastic with one area of the plastic coated with a metal film. The metal film has been treated to make it particularly sensitive to corrosion. One or more matchbook indicators are to be placed in a container with the item(s) to be packaged, and sealed up with the packaged items. If the package has a transparent window area, the indicator can be inspected through the window from the outside. If the walls of the package are all opaque, however, the package must be opened before the corrosion indicator can be inspected. Ordinarily, this type of corrosion

indicator will be used not to monitor an environment, but to indicate that the packaged environment has been non-corrosive or corrosive, and will be inspected only when the package is opened.

1.1.1 Handling precautions. The matchbook corrosion indicator, Figure 1, is extremely sensitive to moisture and shall be kept dry at all times. The sensitized surface shall be kept clean and free from dirt and dust, and shall not be touched. The sensitized indicating film has a very thin protective coating on it to protect it during the time that it is removed from its container and placed in the environment which it is to monitor, plus the package pull-down time, but the time that it is subjected to the open air must be kept to a minimum. The container holding the indicators shall be kept tightly sealed at all times except when indicators are actually being removed. The matchbook corrosion indicator (with the exception of the metal film indicating surface) may be freely and easily handled and positioned with the bare hand, but the hand used to handle the indicator must be clean and dry. No perspiration or moisture of any kind shall be allowed to come into contact with any part of the indicator. The matchbook indicator is fairly rugged and no special handling precautions are necessary other than those of cleanliness, dryness, and minimum exposure to the open air, as discussed above.

> CAUTION - To avoid damage to the matchbook corrosion indicator, do not permit it to become moist or dirty. Do not expose it to the open air any longer than is necessary. Do not touch, or in any way contaminate, the indicating surface.

1.1.2 Installation instructions. Matchbook corrosion indicators must be placed inside the vapor seal of the environment. When only one indicator is used in a package, that indicator should be placed with maximum access to the enclosed air, and as far away from the dessicant as possible. When the shape of the packaged object is complex, or consists of many recesses or crevices having only a single access to the main body of packaged air, it is advisable to use more than one corrosion indicator, and to place one or more in recesses. The latter will then show if any special corrosive effects are taking place in the recesses where residual moisture tends to become trapped. Matchbook indicators may be satisfactorily placed by attaching them to the item being stored with a piece of pressure sensitive tape which can be attached to one end of the indicator, or by suspending them from the grommet in the end of the indicator.

1.1.3 Inspection of matchbook corrosion indicator during use. When used in sealed containers without windows, matchbook indicators cannot be seen from the outside, and thus the package must be opened for inspection. The indicator shall be inspected visually, in light of sufficient intensity to permit the label to be read easily. The appearance of the metal film shall be noted. Only one of the following three conditions shall be reported:

Condition 1: Film area less than approximately 10% corroded.

Condition 2: Film area more than 10% but less than 25% corroded.

Condition 3: Film area more than 25% corroded.

Recommended action based on these conditions is described in section 1.1.4.

1.1.4 Interpretation of results and recommended action. The following information will assist in the interpretation of the results of inspection of the indicators, and in taking proper action therefor.

1.1.4.1 Condition 1 (less than 10% corroded). Condition 1 indicates insignificant exposure to corrosive conditions. Up to 10% corrosion is allowed for initial handling and the pull-down period. No action is required.

1.1.4.2 Condition 2 (10 to 25% corroded). Condition 2 is a transient state which exists for a short period between the time that the atmosphere becomes corrosive and the appearance of Condition 3. Because Condition 2 lasts no more than a few days, this condition will rarely be observed in a random inspection program. Indicated action depends on circumstances. If the packages involved are subject to frequent inspection (monthly or less), no action need be taken other than becoming alert to the possibility of increasing corrosive conditions occurring in the packages as time elapses. If the packages are inspected only infrequently, or if the packaged items are complex or expensive, then Condition 2 may be taken as equivalent to Condition 3 and appropriate action taken (see section 1.1.4.3).

1.1.4.3 Condition 3 (25% or more of area corroded). The appearance of Condition 3 indicates that the atmosphere in question is, or has been, sufficiently corrosive to require corrective action. The packaged item(s) should be unpacked and inspected for corrosion damage. If the Condition 3 is noted within a reasonable time period (usually 60 days) after this condition is reached, no appreciable corrosion damage will have occurred to properly prepared hardware surfaces. Contaminated areas of the surface may show a cosmetic effect within a shorter time period after Condition 3 is first reached on the corrosion indicator sensing element. In any

event, the contents should be repackaged with fresh desiccant, and a new corrosion indicator installed prior to sealing.

1.2 Servicing. The matchbook corrosion indicator is a low-cost, single-shot corrosion indicator and is to be thrown away after use. There is no servicing or repair of the matchbook corrosion indicator.

2. Indicator, Corrosion, Plug, Thin Metal Film, Visual, MIL-xxx.

2.1 Method of use. The plug-type corrosion indicator is to be used to monitor the environment in a sealed package and to indicate when conditions within the package have become such that the packaged item(s) may be subject to corrosion. The plug-type corrosion indicator is shown in Figures 2 and 3. The inside surface of the plastic window is coated with a metal film which has been treated to make it particularly sensitive to corrosion. The plug-type indicator is installed in the wall of a container so that the treated, metal-film-coated surface is exposed to the internal atmosphere. If conditions are potentially corrosive inside the container, the metal-film-coated surface will change color (turn brown). By inspecting the plug-type indicator periodically, a constant check may be made of the conditions within the container.

2.1.1 Handling instructions. Only the inside face of the window of the plug type corrosion indicator, Figure 2, is sensitive to handling. Since it is an assembly, however, the whole unit must be handled so that the metal-film-coated inner window face is not damaged. This window face is sensitive to moisture, and shall be kept dry at all times. The coated inner surface shall also be kept free from all dust and dirt and shall not be touched. The metal film has a very thin protective coating on it to protect it during the time the unit is taken from its container and installed in the wall of the container inside of which is the atmosphere whose corrosive properties the indicator is to monitor. This protective coating is only to protect the film during the installation time and during the package pull-down time, so the length of time it is exposed to the open air must be kept to a minimum. The container holding the plug type corrosion indicators shall be kept tightly sealed at all times except when units are actually being removed. The unit may be freely and easily handled with the bare hand, or with a gloved hand, but the hand or glove used to handle the unit must be clean and dry and free from oil. The plug type indicator shall be kept clean and dry at all times until after it has been installed, at which time it will be exposed to the prevailing conditions of its new environment. Particular care shall be taken to keep the assembly free from all perspiration.

After the indicator has been installed and the container sealed, it is safe to expose the external portion of the plug type indicator to the elements. The inside portion, however, must always be kept clean and dry. Care shall be taken that the gaskets and gasket surfaces are not scratched nor harmed in any way, and care shall be taken that the threads are not physically damaged, burred, nor cross-threaded. The plug type corrosion indicator is a ruggedly built assembly and no special handling precautions are necessary other than those of cleanliness, dryness, and minimum exposure to the open air as described above.

2.1.2 Installation instructions. The plug type corrosion indicator can be installed in the wall of a container providing the exterior of the wall is smooth and flat and the section of the wall in which the indicator is to be placed is not more than 3/16 inches thick. It may also be placed in a waterproof plastic, paper, or other type of vapor barrier. First, a 1-1/32 to 1-1/16 diameter hole should be cut through the wall or vapor barrier. The plug type corrosion indicator should then be removed from its container, disassembled and then reassembled as shown in Figure 2. Care must be taken that one gasket is on the outside of the wall or vapor barrier and that the other gasket is on the inside. The nut should then be screwed onto the body and tightened. The head of the bolt (or body of the indicator) shall be held stationary while the nut is turned. Tightening shall be done from the inside. The nut shall be tightened sufficiently to exert sufficient force through the vapor barrier or wall material to deform the rubber gaskets and effect an air tight seal. After installation the plug type corrosion indicator shall be as shown in Figure 4.

> CAUTION - To avoid damage to the plug type corrosion indicator do not permit it to become moist or dirty. Do not expose it to the open air any longer than is necessary. Do not touch, or in any way contaminate the indicating surface.

2.1.3 Inspection of, during use. It is recommended that the window of the plug type indicator be inspected for evidence of corrosion at intervals of no more than 90 days. The interval should be less for more complex or expensive packaged items, but usually need not be less than four weeks under normal warehouse conditions. A flashlight or other light source should be used to illuminate the window. The light source should be held in such a position that as much light as possible is directed at the metal film, but the light should not be reflected directly into the eyes of the observer. The following conditions shall be noted:

Condition 1: Film area less than 10% corroded.

Condition 2: Film area more than 10% but less than 25% corroded.

Condition 3: Film area corroded 25% or more.

2.1.4 Interpretation of results and recommended action. See Section 1.1.4.

2.2 Servicing. No servicing of the plug type corrosion indicator is ordinarily required. Once it has been installed it should not be tampered with. If a plug type corrosion indicator should be found loose enough to permit air leakage into or out of the container, the indicator shall be carefully checked and if the film shows any trace of corrosion the indicator shall be replaced. After being used, the indicator assembly should be removed and either discarded or returned for rework before being reused.

3. Corrosion Indicating Systems, Electrical Resistance Types, for Packaging, MIL-xxx. These systems operate upon the principle that the electrical resistance of a thin film of a metal increases as corrosion changes the original metal to non-metallic corrosion products. This increase in electrical resistance is converted to an indication of the presence of a corrosive atmosphere by means of two different readout devices.

3.1 Class 1. Corrosion Meter System - General Description. The Corrosion Meter System is used when only spotchecking of the condition of the enclosed sensing element is desired, or where the value of the package does not justify permanent attachment of a Class 2 alarm. The readout is a go, no-go type, showing on a scale that the condition of the indicator, and hence the enclosed atmosphere, is either "GOOD" or "BAD". The corrosion meter system consists of three main parts: the sensing element, the barrier seal feedthrough, and the readout meter. These are shown in Figure 3. The sensing element is shown in Figure 5 and the assembly is shown in Figure 6. An external extension cord may be added if it is desired to locate the meter some distance away from the feedthrough. An internal extension cord may be used to connect the sensing element to the barrier seal feedthrough if it is desired to locate the sensing element some distance away from the vapor seal barrier. (See Figure 7).

3.1.1 Method of use. The corrosion meter system is used in the following manner. A corrosion sensing element is placed on the inside of the vapor seal of a package, and is electrically connected to terminals passing through the wall of the package to the outside. A meter is periodically connected to these terminals. As long as the atmosphere inside the seal remains non-corrosive, the meter shows "GOOD". Should the internal atmosphere become corrosive, the sensing element corrodes rapidly, and after a short time the external

meter will read "BAD" when connected to the sensor terminals. Appropriate action may then be taken. Additional details are given in the following sections.

3.1.1.1 Handling precautions. The three components of the system are subject to different handling requirements.

3.1.1.1.1 Corrosion sensing element. The element is sensitive to moisture and to corrosive conditions. It shall be kept clean and free from all moisture and dirt at all times. Under no circumstances shall the metal film surface be touched or scratched. To handle the element, grasp it between thumb and finger by the edges. The hand shall be clean and dry whenever an element is touched or handled in any way. If the metal film surface should be inadvertently touched by a finger the element shall be discarded. The element shall not be exposed to the open atmosphere at any time for a period longer than that required to remove it from its container and place it in position. If the electrical terminals are bent the element shall be discarded. No attempt shall be made to straighten bent terminals.

3.1.1.1.2 Barrier seal feedthrough. The feedthrough, Figures 8 and 9, requires no special handling precautions. It should be handled as any other electrical item of this general type. The threads shall be kept clean and undamaged and the contacts shall not be damaged or bent. The gaskets shall not be cut or abraded.

3.1.1.2 Installation instructions. The corrosion meter system is designed for use in detecting a corrosive condition of an entrapped atmosphere. The first step of the installation procedure is the installation of the feedthrough. This can be installed in the wall of a container providing the exterior of the wall is smooth and flat and the section of the wall in which the feedthrough is to be placed is not more than 3/16 inches thick. It may also be installed in a waterproof plastic, paper, or other similar type of vapor barrier. First, a 1-1/32 to 1-1/16 diameter circular hole shall be cut through the wall or vapor barrier. The vapor barrier seal feedthrough shall then be installed as shown in Figure 8. Care must be taken that one gasket is on the outside of the wall or vapor barrier and that the other gasket is on the inside. The nut should then be screwed on and tightened. The head of the feedthrough (on the outside of the wall or vapor barrier) shall be held stationary while the nut is turned. Tightening shall be from the inside. The nut shall be tightened enough to exert sufficient force on the vapor barrier or wall material to deform the rubber gaskets and effect an air tight seal. Just before final sealing of the container, the corrosion sensing element shall be removed from its storage container and installed. If the element is to be mounted directly on the feedthrough, the pins

of the element are inserted carefully into the mating terminals of the feedthrough. If the element is to be located elsewhere on the contents, a suitably long internal extension cable is attached to the feedthrough and strung to the desired location, where the inner end may be anchored by means of pressure sensitive tape. The indicator is then connected to this terminus of the cable.

> CAUTION - To avoid damage to the corrosion sensing element do not permit it to become moist or dirty. Do not expose it to the open air any longer than is necessary. Do not touch, or in any way contaminate the indicating surface.

3.1.1.3 Method of reading. To make a reading on a corrosion sensing element, the connector on the end of the corrosion meter cord should be inserted into the external part of the feedthrough. First press the "PUSH TO CHECK METER" button. If the meter battery is in good condition the needle will point to the "METER OK" marking on the scale. Next press the "SHORT CIRCUIT CHECK" button. The needle should now register in the "GOOD" portion of the scale. If the needle points to "BAD", there is a short circuit in the system and the trouble spot must be traced down and corrected. Finally, release all buttons and the needle will point to "BAD" or "GOOD", depending on the condition of the corrosion sensing element. If the needle registers on the border line, this is to be read as "BAD". See Section for recommended frequency for making readings.

3.1.1.4 Interpretation of results. As long as the meter reads "GOOD" in the normal reading position, the atmosphere in the package may be assumed to be non-corrosive. If the reading is good, but the pointer reads close to the borderline between GOOD and BAD, a potentially corrosive atmosphere exists, and inspection and repackaging of the contents is optional, depending on their value and vulnerability to damage by a small amount of corrosion. When the needle points to "BAD" (except on SHORT TEST) the contents of the package should be inspected and repackaged with fresh desiccant.. The time that may be allowed to elapse between the first BAD reading and repackaging depends on the inspection schedule. If all packages are checked at least once per month, so that no more than 30 days can pass before a bad indicator is detected, then the probability is that no appreciable corrosion damage will have occurred to properly prepared hardware surfaces. The package should be opened and the corrosion sensing element inspected visually. If less than 25% of the film surface has corroded (turned brown), no damage

should have occurred to any of the packaged articles. The contents should be repackaged with fresh desiccant, and a new corrosion sensing element should be installed prior to sealing. If more than 25% of the film surface has corroded, the contents of the package should be inspected before repackaging.

3.1.1.5 Multiple installation. It is possible to set up a central station from which the atmosphere of a number of packages at different locations can be monitored. Leads can be brought in from each of the different locations at which a corrosion sensing element is installed. These leads can be connected to a selector switch. In this way the condition of any number of corrosion sensing elements may be determined from one location. The same sequence of testing should be followed for each location, or setting of the selector switch, as has been described for an individual location. See 3.1.1.3. It should be kept in mind that the maximum distance which can be permitted between the corrosion sensing element and the meter, and still permit satisfactory operation of the system, is limited by the size of the connecting wire. The "SHORT CIRCUIT CHECK" circuit will not indicate a short circuit if the external circuit resistance is more than three ohms. If too long a length of connecting wire is used, the resistance of the wire itself may exceed this value, and the short circuit check circuit will be unable to detect a short in the external system. For these reasons, the maximum lengths of two-conductor wire which should be run between the meter and the corrosion sensing element should not exceed the following:

Wire Gauge (Copper Wire)	Maximum Length of 2-conductor Line To Be Used
14	500 feet
16	300 feet
18	200 feet
20	125 feet
22	75 feet

3.1.2 Servicing of corrosion meter system.

3.1.2.1 Corrosion sensing element. No servicing shall be performed on the corrosion sensing element. If it is damaged, the terminals are bent, or the film surface is scratched, fingermarked, or dirty, throw it away.

3.1.2.2 Cord. The cord requires no special handling precautions. It should be handled in the same manner as any other electrical cord of this type. It shall not be physically damaged

in any way nor shall the outside covering be cut or abraded. The end fittings shall be kept clean and dry.

3.1.2.3 Barrier seal feedthrough. The feedthrough, Figure 6, requires no special handling precautions. It should be handled as any other electrical item of this general type. The threads shall be kept clean and undamaged and the contacts shall not be damaged or bent. The gasket shall not be cut or abraded.

3.1.2.4 Corrosion meter. The only servicing of the corrosion meter which should be required is the replacement of the battery. If the needle does not point to the "METER OK" section when the "PUSH TO CHECK METER" button is depressed the battery is probably bad. To replace the battery, remove the screws holding the cover in place. Then remove the cover and take out the old battery. Install a new battery of the correct style and size as shown in the diagram on the inside of the case. Be certain that the battery is installed as shown in the schematic diagram on the inside bottom of the case.

CAUTION - Make certain that correct polarity is observed in installing battery.

3.2 Class 2, Visual Alarm System - General Description. The visual alarm system is as shown in Figure 10. The same corrosion sensing element, cord and barrier seal feedthrough are used as with the Class 1, Corrosion Meter System. The visual alarm system is to be used for continuous monitoring of an enclosed environment. As long as the element remains in a relatively uncorroded condition, the light on the visual alarm indicator box will remain out. When the element has corroded to the extent that its electrical resistance exceeds a pre-determined amount, indicating that the corrosiveness of the contained atmosphere has exceeded a tolerable level, the light will start to flash and will continue to flash until the alarm is disconnected or the battery runs down. (Flashing life of more than three months).

3.2.1 Method of use. The corrosion sensing element consists of a small piece of electrically non-conducting plastic with a thin metal film coating on one side and two terminals extending from the other side as shown in Figure 5. The metal film completes the circuit between the two terminals. As the corrosion products of the metal film are essentially non-conducting, any corrosion of the metal film will result in an increase in its resistance. When the resistance of the indicator exceeds a pre-determined value, it triggers a circuit in the visual alarm box to start the light flashing. To use the visual alarm system to warn of a potentially dangerous

corrosive condition it is only necessary to place a corrosion sensing element where the atmosphere may become corrosive and connect it electrically to the visual alarm indicator box. A barrier seal feedthrough is used when the element is located within a sealed container. The indicator box may be located wherever it is desired since it need only be connected electrically to the indicator.

3.2.1.1 Handling precautions. The different components of the system are subject to different handling requirements.

3.2.1.1.1 Corrosion sensing element. The corrosion sensing element is sensitive to moisture and corrosive conditions. It shall be kept clean and free from moisture and dirt at all times. Under no circumstances shall the metal film surface be touched or scratched. To handle the element, grasp it between thumb and finger by the edges. The hand shall be clean and dry whenever a corrosion sensing element is touched or handled in any way. If the metal film surface should be inadvertently touched by a finger the element shall be discarded. The element shall not be exposed to the open atmosphere at any time for a period longer than that required to remove it from its container and place it in position. If the electrical terminals are bent, the element shall be discarded. No attempt shall be made to straighten bent terminals.

3.2.1.1.2 Cord. The cord requires no special handling precautions. It should be handled in the same manner as any other electrical cord of this type. It shall not be physically damaged in any way nor shall the outside covering be cut or abraded. The end fittings shall be kept clean and dry.

3.2.1.1.3 Barrier seal feedthrough. The feedthrough, Figure 8, requires no special handling precautions. It should be handled as any other electrical item of this general type. The threads shall be kept clean and undamaged and the contacts shall not be damaged or bent. The gasket shall not be cut or abraded.

3.2.1.1.4 Visual alarm meter box. The alarm box contains delicate electronic equipment and shall be handled in the same fashion as standard electronic test items such as ohmmeters, ammeters, etc. It shall not be dropped or struck or subjected to any unnecessary shock. The alarm box shall be carried in the hand or in a container and shall not be supported by its cord. It shall be kept clean and dry.

3.2.1.2 Installation instructions. The visual corrosion alarm system is designed to continuously monitor an enclosed environment and to indicate, by means of a flashing light, when the corrosivity has exceeded a tolerable level. The first step of the installation procedure is the installation of the barrier seal feedthrough. This can be installed in a wall of the container providing the exterior of the wall is smooth and flat and the section of the wall in which the feedthrough is to be placed is not more than 3/16 inches thick. It may also be installed in a waterproof plastic or other similar type of vapor barrier. First, a 1-1/32 to 1-3/64 diameter circular hole shall be cut through the wall or vapor barrier. The vapor barrier feedthrough shall then be installed as shown in Figure 8. Care must be taken that one gasket is on the outside of the wall or vapor barrier and that the other gasket is on the inside. The nut should then be screwed on and tightened. The head of the feedthrough (on the outside of the wall or vapor barrier) shall be held stationary while the nut is turned. Tightening shall be from the inside. The nut shall be tightened enough to exert sufficient force on the vapor barrier or wall material to deform the rubber gaskets and effect an air tight seal. Just before final sealing of the container the corrosion sensing element shall be removed from its storage container and installed. If the element is to be located on the barrier, the pins are inserted into the terminals on the inside of the feedthrough. If it is desired to locate the corrosion sensing element some distance from the wall of the container, the terminals of the element should be inserted into the socket on the end of the cord, the other end of which is plugged into the feedthrough.

> CAUTION - To avoid damage to the indicator do not permit it to become moist or dirty. Do not expose it to the open air any longer than is necessary. Do not touch, or in any way contaminate the indicating surface.

After the indicator has been installed and the container sealed, the visual alarm box may be located wherever it is desired and shall be connected to the outer terminals of the feedthrough by a cord of an appropriate length with the correct fittings on each end.

3.2.1.3 Periodic checks. After the visual corrosion alarm system has been installed, the knob marked TEST should be turned to the position marked CIRCUIT and held there for at least five seconds. If the light flashes, both battery and light are in good condition. If the light should fail to flash, see section 3.2.2.4 for servicing. Next, turn the knob

marked TEST to the position marked SHORT and hold there for at least five seconds. If the light flashes, there is a short circuit in the system. These two tests should be performed periodically to test for short circuit and for battery life. After performing these tests, release the knob and it will return to the center, operating position. If the alarm light should start blinking when the knob is in the center position, it could indicate the presence of a corrosive condition where the sensing element was located, or it could indicate an open circuit or discharged batteries. Check all connections carefully to make certain they are tight. If no loose connection is found, it is probable that a corrosive condition exists at the location of the sensing element. To make certain, open the package and examine the sensing element visually. If a large part of the metal-film-coated surface is brown or rust colored, a corrosive condition exists which should be corrected at once. (See also 3.1.1.3). See 3.1.1.4 for multiple installations and the maximum tolerable length of line between the corrosion alarm meter and the corrosion sensing element.

3.2.1.4 Interpretation of results. As long as the light on the alarm box remains out, the atmosphere may be assumed safe, provided there is no internal short (see 3.2.1.3 for short test procedure). If the light begins to flash, there are three possibilities:

1. The batteries are dead.
2. The batteries and the element are both still good, but there is a high resistance contact or an open circuit in the external leads.
3. The batteries and leads are good, but the sensing element has corroded.

The first two possibilities must be eliminated before a positive decision regarding the element may be made. Possibility 1 should be checked first using the CHECK ALARM test switch. Possibility 2 should then be checked by inspecting the connectors and leads external to the package. Connections should be made and remade to assure good contact. If meter and connections are in order, then the sensor must be corroded. The package should be opened for inspection. First visually inspect the sensing element for confirming evidence of corrosion. If corrosion of the film was responsible for the alarm signal, the element will appear rusted over a portion of the total area. If this is the case, then the hardware should also be inspected and repackaged. (If no corrosion is visible on the film, the internal connections should be inspected for a high-resistance joint.)

3.2.2 Servicing.

3.2.2.1 Indicating element. No servicing shall be performed on the indicating element. If it is damaged, the terminals are bent, or the film surface is scratched, finger marked, or dirty, throw it away.

3.2.2.2 Cord. No servicing is required for the cord.

3.2.2.3 Barrier seal feedthrough. No servicing of the feedthrough is ordinarily required. Once it has been installed it should not be tampered with.

3.2.2.4 Visual corrosion alarm. The only servicing of the visual alarm that should be required is replacement of the batteries or replacement of the neon lamp bulb. There are two sets of batteries in the visual alarm instrument box. One set of batteries acts to prevent the flow of current to the neon lamp until the external resistance (the resistance of the corrosion sensing element) exceeds a pre-determined value. The other set of batteries supplies the power to cause the neon lamp to flash when the resistance of the sensing element exceeds the pre-determined value, causing the control circuit to trigger. Both sets of batteries should be replaced every 12 months. Particular care should be exercized to make certain that the correct polarity is observed when installing new batteries. Follow the schematic diagram attached to the underside of the cover. Battery replacement requirements are listed on the schematic diagram. If the neon lamp should be broken, or require replacement for any other reason, the replacement requirements for it are also given on the schematic diagram.

4. Storage requirements.

4.1 Storage of metal-film-coated indicating elements. All of the metal-film-coated indicating elements, whether they indicate corrosive conditions by changing color or by changing electrical resistance, are similar in the way they are made. Each has a metal-film coating on a plastic substrate and each metal film is in turn treated over a portion of its surface with a sensitizing agent to cause it to corrode rapidly when it is exposed to a corrosive atmosphere. Each indicating film also has a very thin protective coating on it to protect it during the time that the indicator is removed from its container and placed in the environment which it is to monitor, plus the package pull-down time. The action of the protective coating is very important and the balance is delicate. Any change in its concentration or its chemical composition can upset this balance and alter the response of the indicator. If there is a

great enough change in the protective coating, the reaction of the indicator will change so much that the results obtained from it will not be reliable. Substantial changes in the protective coating can occur as a result of extended storage at an extreme temperature. For this reason, the temperature of the stored indicators or sensing elements must be controlled. For extended storage the temperature of the indicators should not be permitted to exceed 90°F nor should it be allowed to drop below 30°F. After an indicator has been placed in use, variations in the protective layer due to temperature will have only minor effects on its accuracy. Temperature control is necessary only during storage.

SECTION III - REPAIR INSTRUCTIONS

1. Indicator, corrosion, "matchbook", metal film, visual, MIL-xxxx. This is a low-cost, expendable item for use once and once only. It is not repairable or reuseable.

2. Indicator, corrosion, plug, thin metal film, visual, MIL-xxxx.

2.1 The plug type corrosion indicator is shown assembled in Figure 4. Of the parts which combine to form the complete assembly, only the window, with its metal-film-coated surface, the window gaskets, and the sealing gaskets are ordinarily subjected to wear or require replacement under normal conditions. These items should be replaced after every use. To remove the window it is only necessary to remove the retainer ring and push the window out of the body. The window and window gaskets should then be disposed of, along with the sealing gaskets. A new window and window gaskets may then be installed in the body. It should be noted here that only an ordinary Allen wrench, one-half inch size, is necessary to remove and replace the retainer ring. Disassembly of the plug type corrosion indicator may be performed in any convenient location. Assembly and installation of new windows, however, shall be performed only in a controlled, dry atmosphere of less than 40% relative humidity. The parts shall be cleaned and thoroughly dried before reassembly. The replacement window shall be removed from its container and placed in the body in the position as shown in Figure 4. Particular care shall be taken to keep from touching the inner, coated face of the window. Should this face be touched by a finger (fingerprinted) the window (but not the metal plug assembly) shall be discarded, since a fingerprint impression on this surface will destroy the usefulness of the indicating surface. Before the new window is installed the "O-ring" sealing gasket should be replaced with a new "O-ring" gasket. The window should then be set in place and the retaining ring, with its gasket, screwed in tightly to effect a pressure seal. The retaining ring gasket need be replaced only if it is visibly damaged. The "O-ring" gasket shall be replaced each time a new window is installed. Three new sealing gaskets shall be installed on the body and the nut screwed on finger tight. The assembly shall be then placed in an air tight container with the proper amount of desiccant and sealed. The assembled plug type corrosion indicator shall be protected from moisture and dirt at all times until installed. Other parts of the plug type corrosion indicator assembly may be replaced as they become lost or damaged in use.

3. Corrosion indicating systems, electrical resistance types, for packaging, MIL-xxx.

3.1 Class 1, corrosion meter system.

3.1.1 Indicating element. This is a low cost, expendable item, see Figure 5, for use once and once only. It is not repairable or reuseable. If the terminals become bent, do not try to straighten them. Throw the element away. Any bending or lateral force on the terminals is apt to damage or destroy the electrical contact between the terminal and the metal film. This could result in a malfunction of the entire system.

3.1.2 Cord. The cord is a length of two-conductor electrical cord, Belden 8414 or equivalent, with terminals on both ends. The terminals are sealed to the outside insulation of the cord, as shown in Figure 7, to make the junction air-tight and moisture-proof. If the cord should become damaged in use, or the insulation broken, the cord should be discarded unless one of the undamaged sections is long enough to warrant the cost of repairing.

3.1.3 Vapor barrier seal feedthrough. The feedthrough is shown in Figure 6. There is very little of this item that is repairable. Burred or damaged threads can be smoothed and reworked. The rubber gaskets should be replaced before each reuse.

3.1.4 Corrosion meter. The wiring diagram for the corrosion meter is shown on the inside of the case. Components can easily be checked with an ohmmeter and replaced if necessary. If the indicating meter should be damaged or broken by mishandling it can be replaced. If it should prove necessary to replace the indicating meter or any of the resistors, the reworked corrosion meter should be equipped with a new battery and the needle adjusted to point to the METER OK mark on the dial. If the cord or the terminals should be damaged, the cord assembly should be replaced. All electrical connections should be carefully soldered. The case should be carefully closed and sealed each time it is opened. Replace the gasket if it is damaged. Battery replacement is explained in 3.1.2.4.

CAUTION:

Do not use an acid core solder or any type of acid flux in soldering electrical connections in this meter.

3.2 Class 2, visual alarm system.

3.2.1 Indicating element. See 3.1.1.

3.2.2 Cord. See 3.1.2.

3.2.3 Vapor barrier seal feedthrough. See 3.1.3.

3.2.4 Visual alarm meter. The wiring diagram for the visual alarm is shown in the inside of the case. Replacement of batteries and neon lamp is discussed in 3.2.2.4. If anything should go bad with the circuit due to mishandling or circuit corrosion, the visual alarm should be repaired in accordance with the given circuit. If the cord or terminal should be damaged, the cord assembly should be replaced. All electrical connections should be carefully soldered. The case should be closed and sealed each time it is opened. Replace the gasket if it is damaged.

CAUTION:

Do not use an acid core solder or any type of acid flux in soldering electrical connections in this meter.

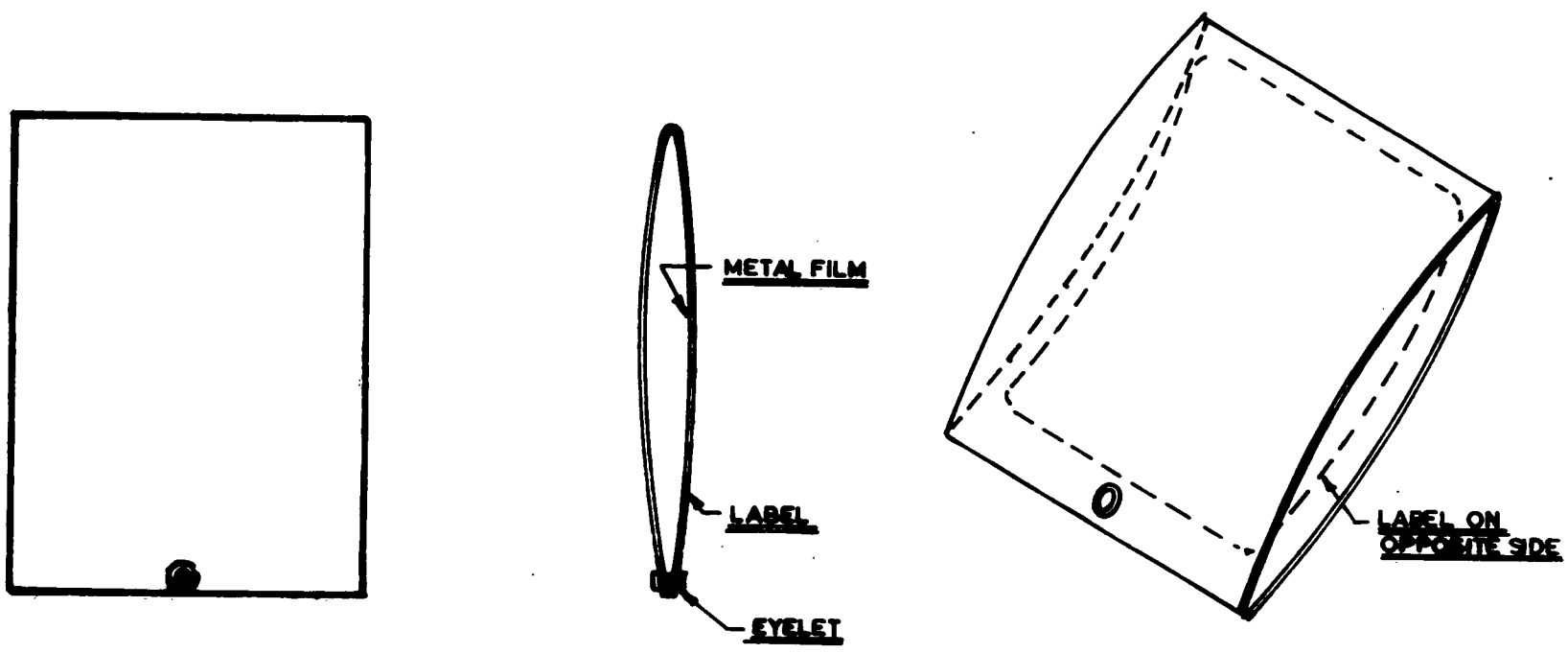


FIGURE 1

MATCHBOOK CORROSION INDICATOR

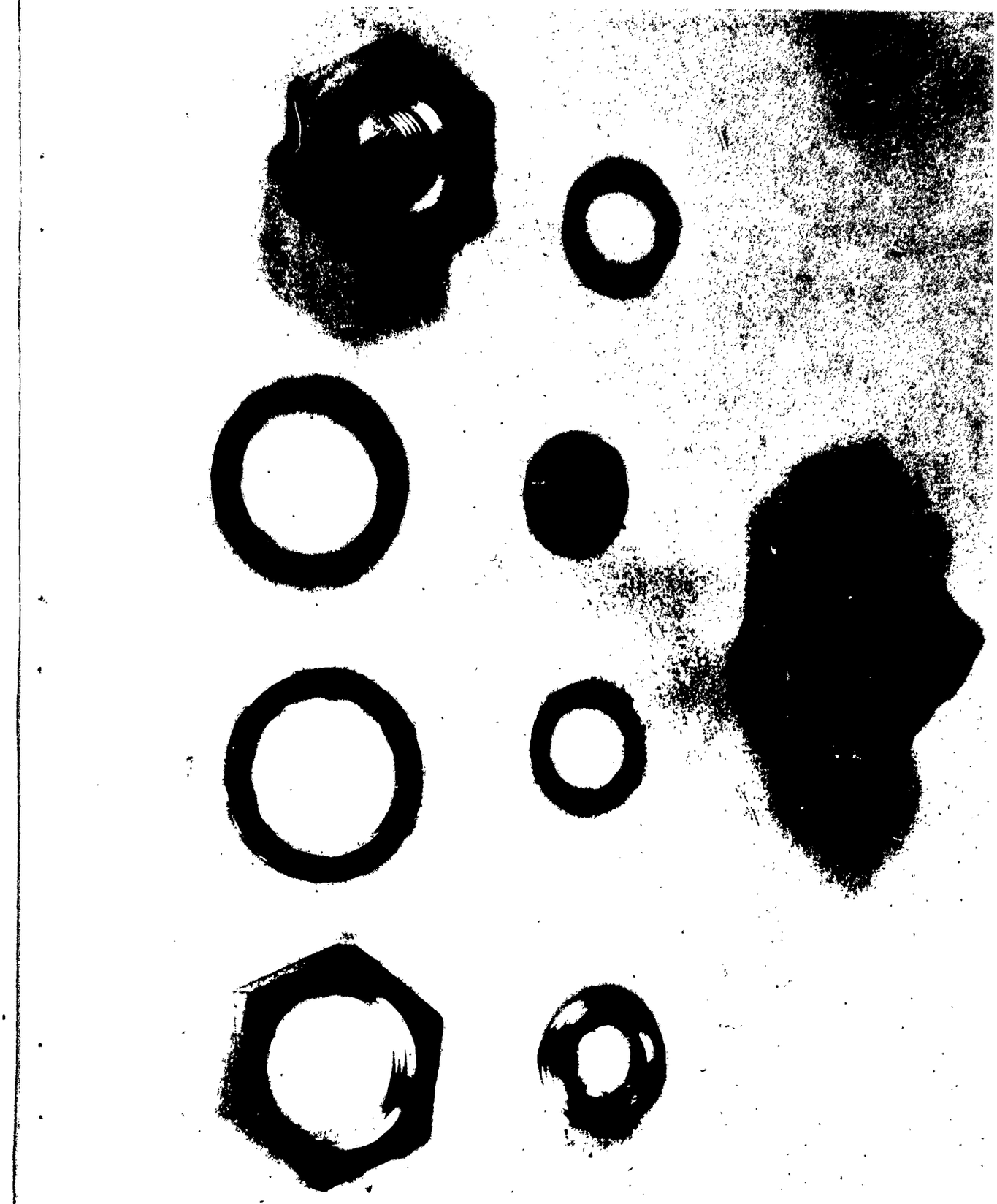
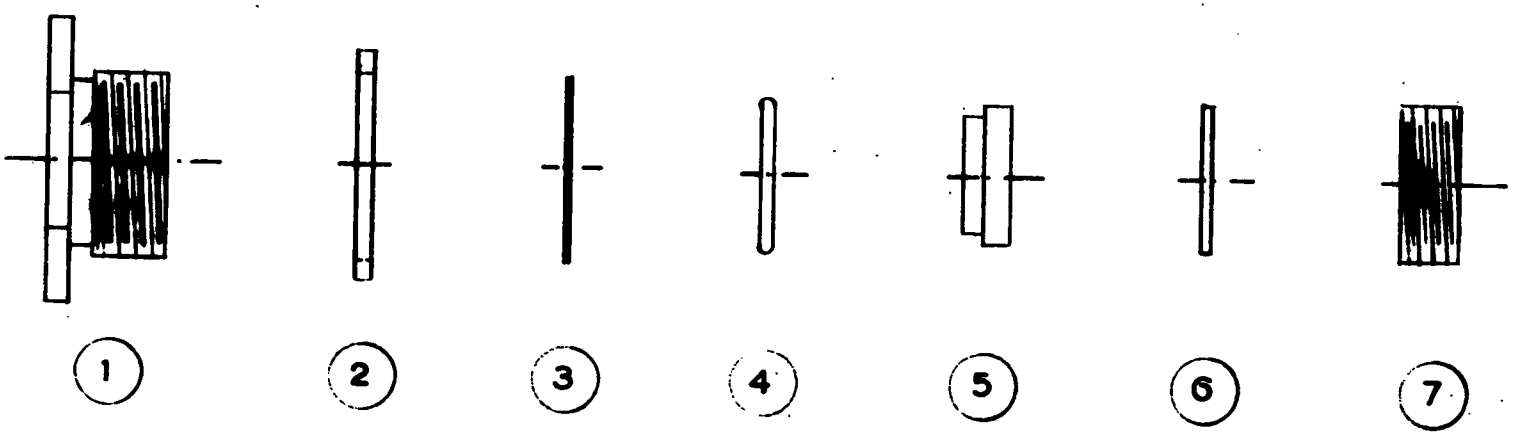
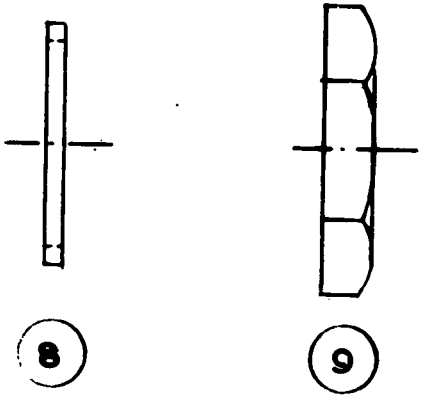
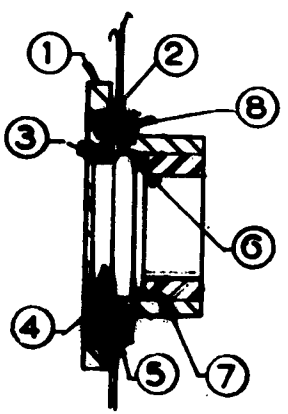


Figure 2. Indicator Plug - Pictorial View



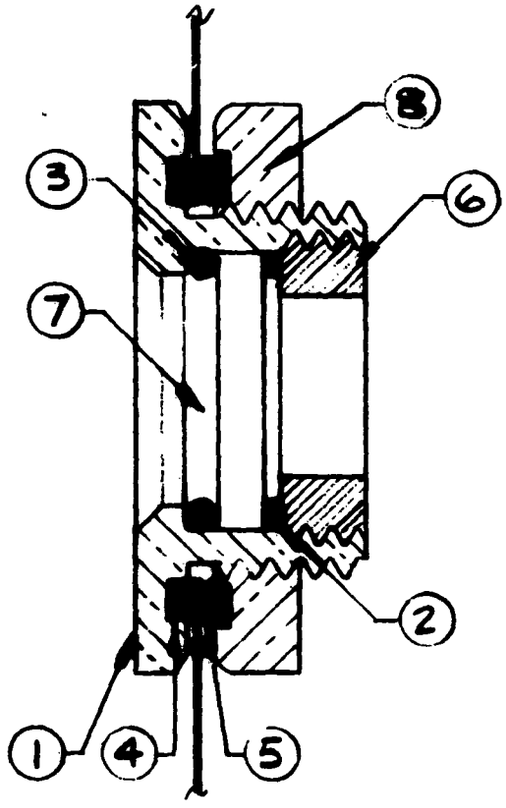




ITEM	DESCRIPTION
9	NUT
8	GASKET (OUTER)
7	RETAINER RING
6	WINDOW, WASHER
5	WINDOW, INDICATOR
4	O RING
3	GASKET (BARRIER)
2	GASKET (INNER)
1	BODY

FIGURE 3

CORROSION INDICATOR



8	LOCK NUT	AL
7	WINDOW	PLASTIC
6	RETAINER	BRASS
5	GASKET	RUBBER
4	GASKET	RUBBER
3	O'RING	RUBBER
2	WASHER	RUBBER
1	BODY	AL

FIGURE 4
PLUG TYPE CORROSION INDICATOR

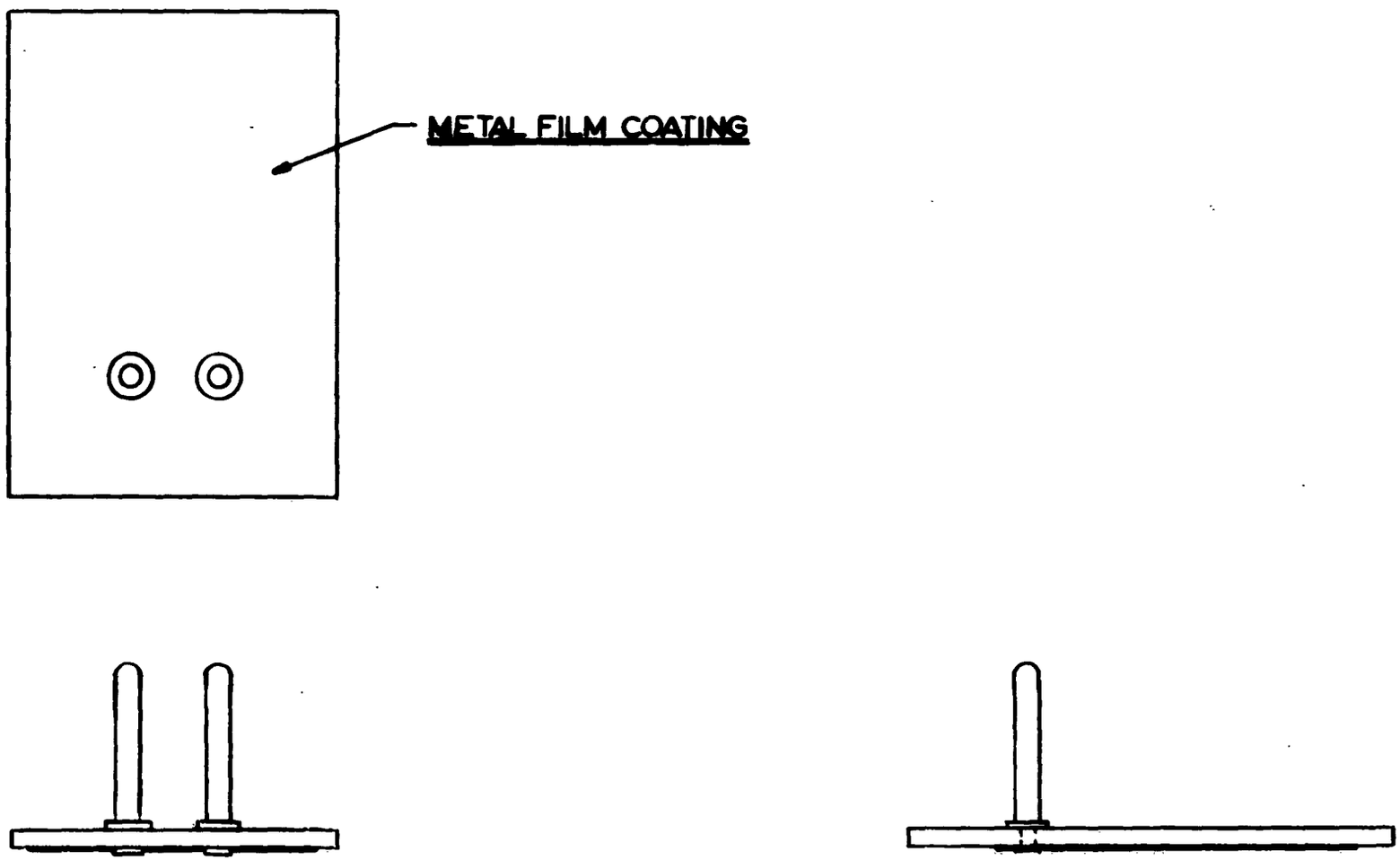


FIGURE 5
CORROSION SENSING ELEMENT

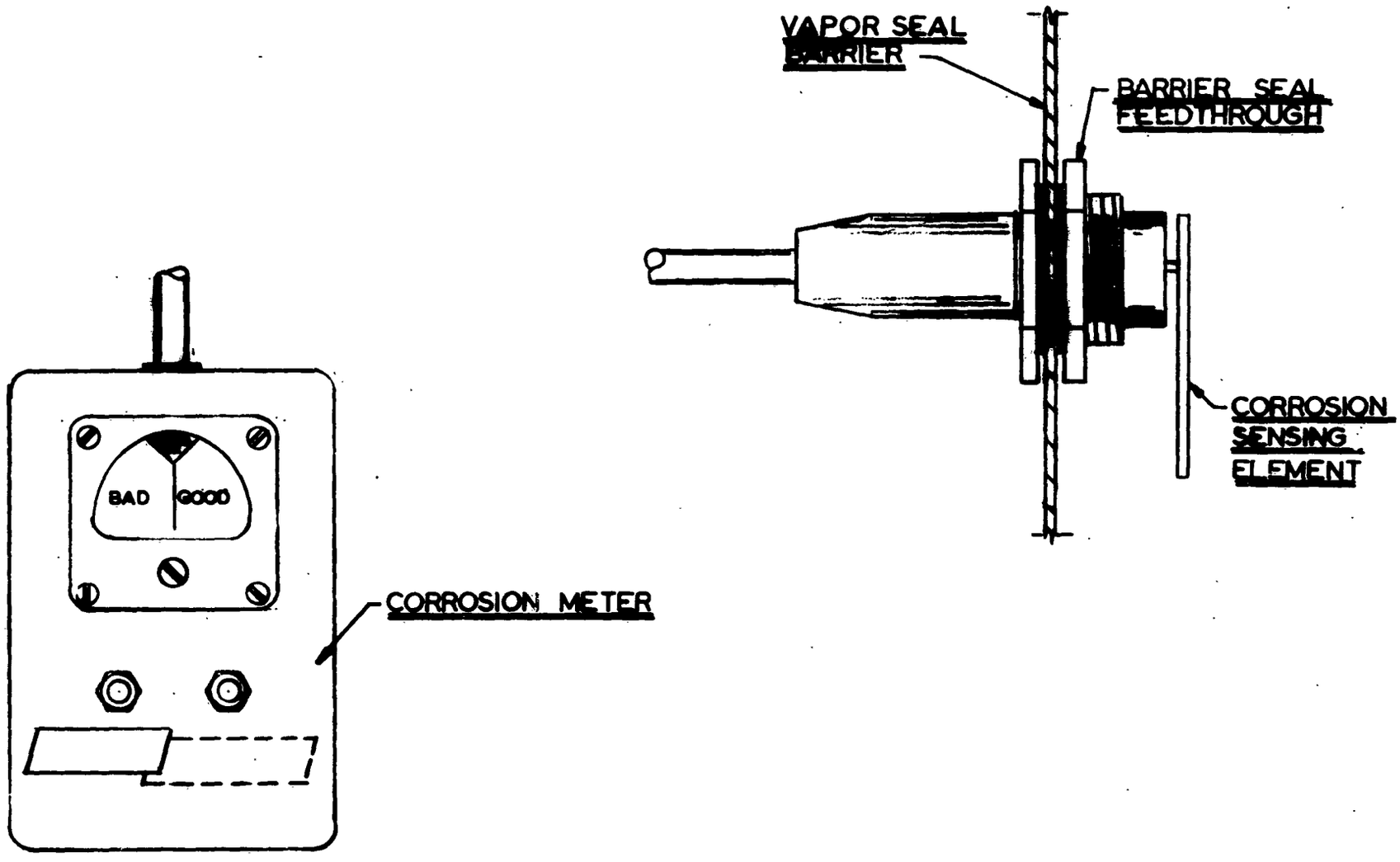


FIGURE 6
CORROSION METER SYSTEM

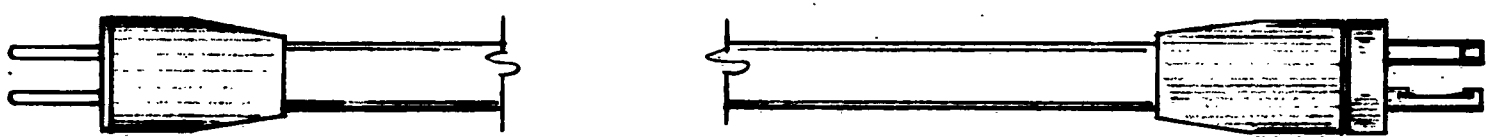
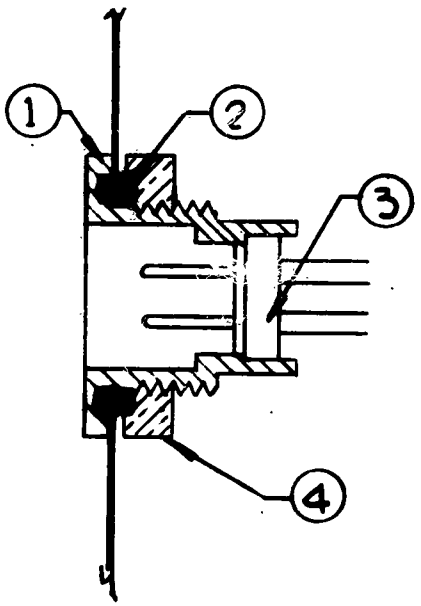


FIGURE 7.
EXTENSION CORD



4	LOCK NUT	AL
3	CONTACT SOCKET	
2	GASKET	RUBBER
1	BODY	AL

FIGURE 8

BARRIER SEAL FEEDTHROUGH

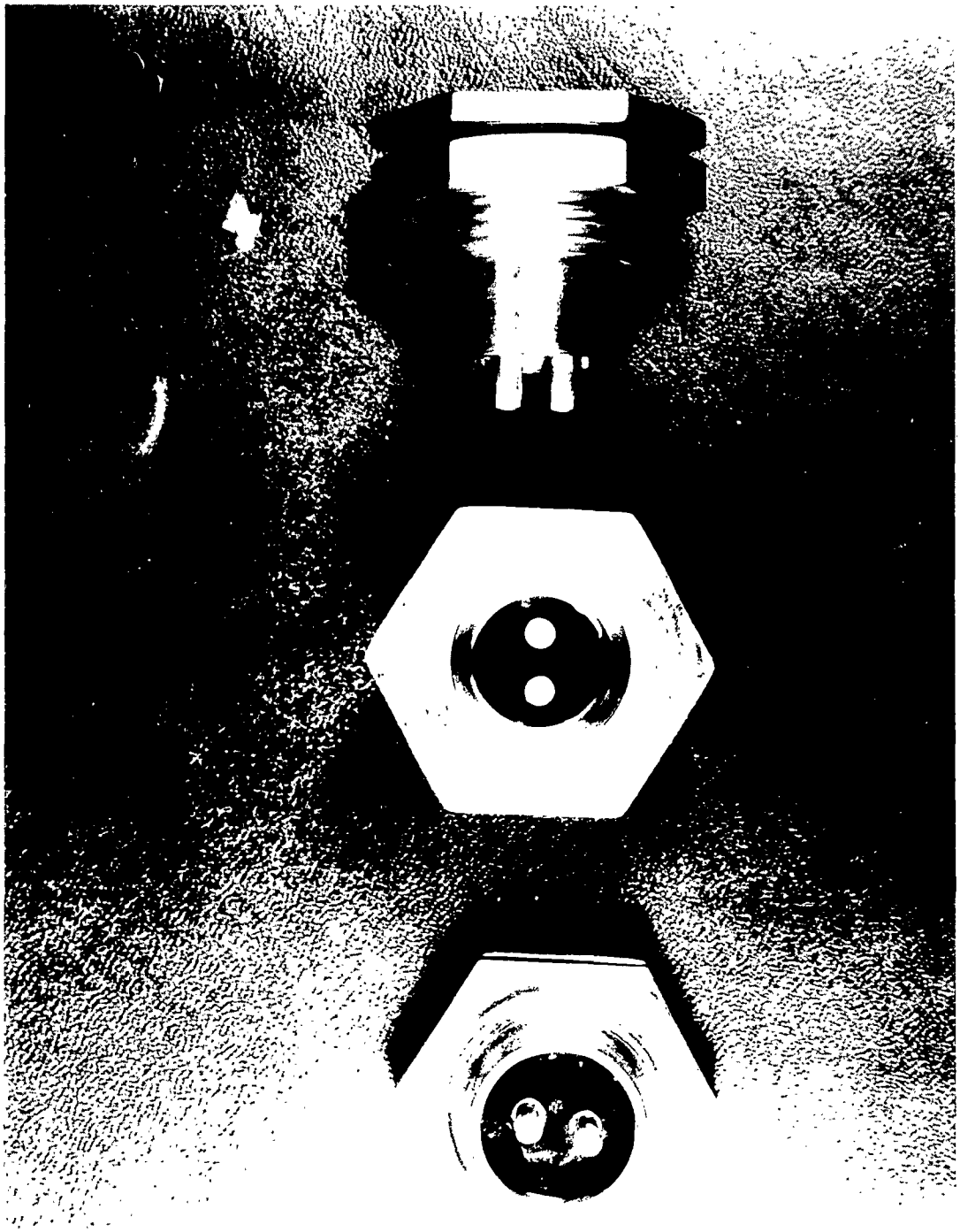
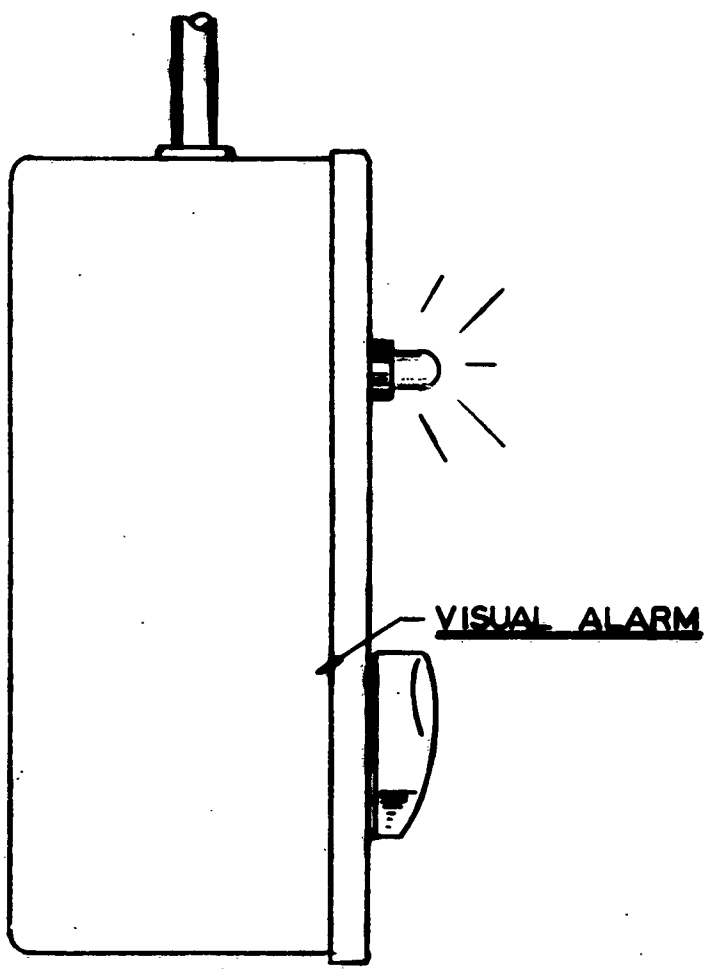


Figure [illegible] Seal Feedthrough



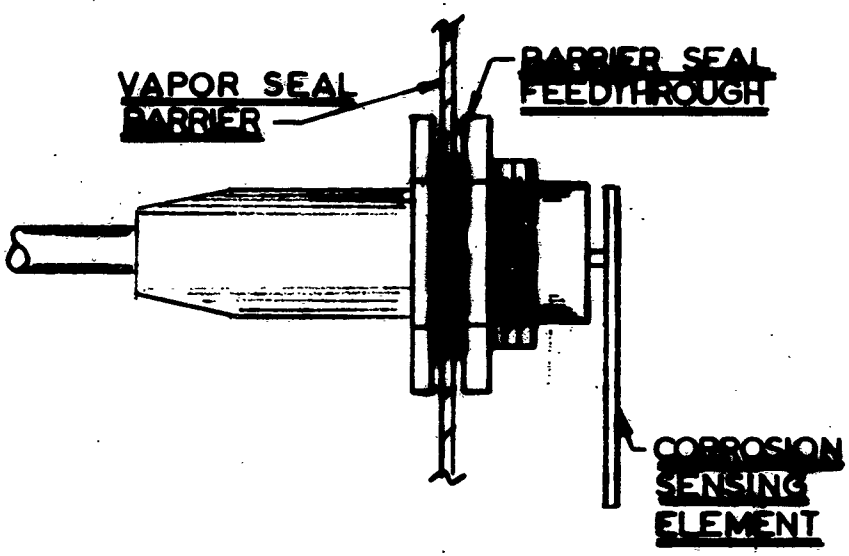


FIGURE 10
VISUAL ALARM SYSTEM